European Commission

JRC SCIENCE FOR POLICY REPORT

RIO COUNTRY REPORT 2015: United Kingdom

Paul Cunningham
Jessica Mitchell

2016

EUR 27875 EN

Joint Research Centre

Contact information
Address: Edificio Expo. c/ Inca Garcilaso, 3. E-41092 Seville (Spain)
E-mail: jrc-ipts-secretariat@ec.europa.eu
Tel.: +34 954488318
Fax: +34 954488300

JRC Science Hub
https://ec.europa.eu/jrc

JRC101221

EUR 27875 EN

PDF ISBN 978-92-79-57810-6 ISSN 1831-9424 doi:10.2791/240743 LF-NA-27875-EN-N

How to cite: Paul Cunningham, Jessica Mitchell; RIO Country Report 2015: United Kingdom;
EUR 27875 EN; doi:10.2791/240743

Abstract
The 2015 series of RIO Country Reports analyse and assess the policy and the national research and innovation system developments in relation to national policy priorities and the EU policy agenda with special focus on ERA and Innovation Union. The executive summaries of these reports put forward the main challenges of the research and innovation systems.

Table of Contents

Foreword

The report offers an analysis of the R&I system in the United Kingdom for 2015, including relevant policies and funding, with particular focus on topics critical for EU policies. The report identifies the main challenges of the UK research and innovation system and assesses the policy response. It was prepared according to a set of guidelines for collecting and analysing a range of materials, including policy documents, statistics, evaluation reports, websites etc. The quantitative data is, whenever possible, comparable across all EU Member State reports. Unless specifically referenced all data used in this report are based on Eurostat statistics available in February 2016.

Acknowledgments

Comments on this report from DG Research and Innovation are gratefully acknowledged. From DG JRC, Peter Fako, Lorenzo Isella and Athina Karvounaraki produced the statistics and the analytical assessments for sections 3.2 and 3.6 of the report. We would like to thank Sophie Bodart, Martine Troonen and Françoise Gandrey for their assistance in preparing this report for publication.

Authors' affiliation:
Paul Cunningham, Manchester University (Manchester, UK)

Jessica Mitchell, European Commission, Directorate-General Joint Research Centre, Directorate J - Institute for Prospective Technological Studies, Innovation Systems Analysis unit (Brussels, Belgium)

Executive summary

This report provides an analysis of the R&I system, policies and funding in the United Kingdom in 2015, taking into account the European Research Area priorities and the Innovation Union. The report was prepared according to a set of guidelines for collecting and analysing a range of materials, including policy documents, statistics, evaluation reports, websites, etc. The quantitative and qualitative data is, whenever possible, comparable across all EU Member State reports.

Context

The UK economy is recovering from the effects of the 2008 financial crisis. There are signs of annual GDP growth, and employment continues to rise and unemployment fall - a general trend since late 2011. However, two important, long-standing concerns in the wider economy are weak productivity growth (notably labour) and low business investment.

Evidence of smart fiscal consolidation – balancing government budgets while safeguarding research and development (R&D) investments – is not strong enough to conclude whether the UK post-crisis fiscal adjustment process has come at the expense of public support to UK R&D. While the share of GDP for public R&D has declined since the 2008 crisis, the process of fiscal consolidation has so far led to mixed results, with some improvements both nominally and structurally, although the government debt and deficit are still far from pre-crisis levels. A system of tax incentives to stimulate R&D spending has produced noticeable results, yet these appear to have been insufficient to reverse the trend mentioned above. Cuts to the government support of R&D have affected the public sector more than the business sectors, in which the latter saw an increase in funding from government in recent years.

The UK spends 1.7% of GDP on R&D, representing a gross expenditure on R&D (GERD) of €34b (around 12% of total EU-28 GERD). Of this, 28% is from public sources, 21% from abroad and 51% from the private sector. Although there is no current official R&D target, the Government's ten-year Strategic Innovation and Investment Framework, 2004-2014 (BIS, 2011) set an ambition to reach a ratio of GERD to GDP of 2.5% by 2014. An important limiting factor in achieving this target is the effect of the economic recession and ongoing recovery.

UK R&D policy-making is centralised, although devolution in Northern Ireland, Scotland and Wales, extends some decision-making relating to the innovation system. Overall, the UK is a R&D leader, both among the EU28 and globally, on many measures. It has a significant number of world-class and highly innovative sectors such as pharmaceuticals, aerospace and automotive, as well as new sectors like digital design.

Key developments in the R&I system in 2015 include:

- Formation of a majority Conservative government following the General Election
- Comprehensive Spending Review undertaken

The UK R&I system is addressing ERA priorities, building on its generally strong performance, notably in research infrastructures, open access, international cooperation and researcher mobility. There is some scope to improve on this in order to boost R&I performance and economic and societal wellbeing.

The UK's R&I system has demonstrated successes in knowledge exchange with extensive collaboration between the public, private and not-for-profit sectors through formal programmes, ad hoc activities, as well as in the large numbers of science parks, incubators and similar ventures.

Four of the main challenges for the UK's R&I system are:

1. Increasing public and private sector investment in R&I;
2. R&D specialisation and commercialising public R&D;
3. Boosting support to scale-ups, including high-growth innovative enterprises;
4. Ensuring future supply of human resources in S&T.

Challenge 1: **Increasing public and private sector R&I investment**

Description

Investment in research and innovation is an important element for economic recovery, growth and societal well-being. However, the UK has experienced a sustained, long-term pattern of under-investment in public and private research and development (R&D). It ranks 18th on public expenditure and 14th for private expenditure, investment in non-R&D innovation is ranked 29th (IUS, 2015). The UK invests the least in R&D compared with similar advanced economies, and while UK foreign-owned firm R&D is high, UK-owned firm R&D is a concern.[1] Although UK science is highly productive in some areas – it ranks 4th for exports in knowledge intensive services, has one of the highest shares of high-impact publications in the world, several universities at the forefront of global university league tables, and ranks 63.5 compared with Germany, (59) and France (58.1) on the EU research excellence indicator - it is uncertain that these R&I outputs can be sustained amidst stagnating or declining investment.

Policy response

Successive governments have detailed the issue of weak investment over a number of years. Most policy attention is focused on boosting private sector R&D investment rather than increasing public sector expenditure. The decline in the latter is partly due to R&D budget cuts in ministries other than the Department for Business Innovation and Skills that did not ring-fence their R&D investments (CaSE, 2014). Although the budget for science and research did not suffer from cuts in nominal terms, it has declined for some time in real terms It is now steady at £4.7 billion and it will be protected in real terms over the Parliament. This will include a £1.5 billion new Global Challenges Fund. The Government aims to boost private sector funding largely through indirect measures such as the R&D tax credits for large companies and SMEs. There are also a smaller range of awareness promotion, prizes, and advisory service measures. In terms of direct measures, Innovate UK provides support funds for industry and SMEs, and runs the 10 Catapult centres set-up across the UK to enhance industry funding to public R&D along the lines of the Fraunhofer model. In 2012, the Innovation Vouchers programme was formally launched to enable start-ups and SMEs to access advice and expertise from universities, research organisations or other private-sector knowledge providers. The Launchpads scheme supports the development and strengthening of clusters of high-technology companies in specific technologies and geographical locations. Launchpads provide base funding through approved R&D projects and act as a catalyst to help the companies behind the projects to attract more investment. A new national development bank, the British Business Bank aims to increase the supply and diversity of finance available for UK SMEs (OECD, 2014).

[1] However, BIS (2014a) points out that private sector investment in scientific R&D forms only part of the picture: Whilst this amounted to almost £16b (c. €20b) in 2011, investment in training has more than doubled since 1990 and exceeded £33b (c. €41b). Moreover, investment in computerised information and databases exceeds £24b (c. €30b) and design £15.5b (c. €19b). Moreover, the UK increased its investment in such 'intangibles' by £3b (c. €3.75b) to £138b (c. €173b), compared with £90b (c. €112b) investment in tangible assets between 2010 and 2011.

Assessment

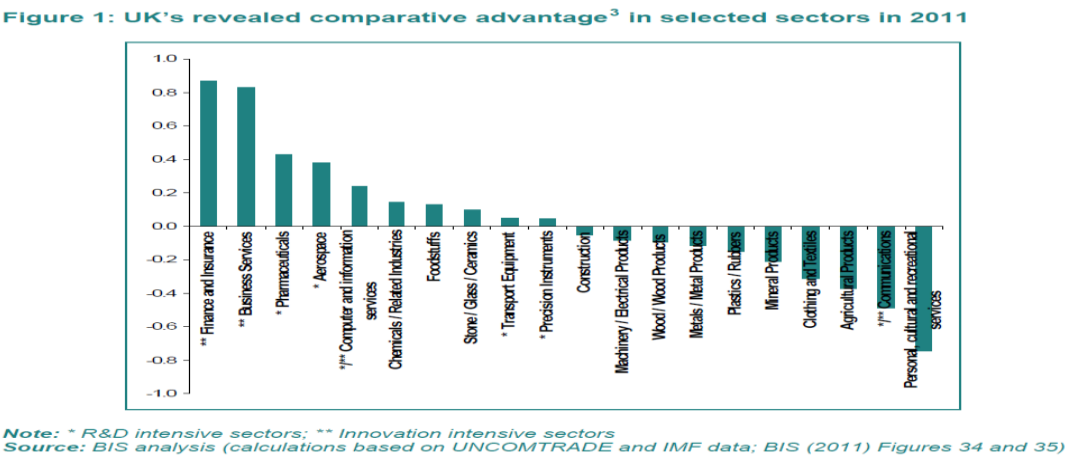
An evaluation of the tax credit scheme found that it had a positive impact, and provided additionality by leveraging private investment; however SMEs may not be benefiting as much as larger industry from the current measures (HMRC, 2015). The total number of companies supported has risen from 1,780 in 2000/01 to 11,920 in 2011/12, and claims are estimated to cover around two-thirds of all spending by businesses on R&D (Cunningham, 2015). In terms of their appropriateness and impact, the focus on tax credits offers a demand-led flexible support according to the needs of each company. On the other hand, government has less flexibility to prioritise funding on certain sectors or technologies. More importantly, it is unclear from evaluations to date whether they have had any impact on stimulating overall business R&D investments, therefore a closer evaluation of the tax credit scheme could serve to clarify this issue. The funding impact of the recently established Catapult centres is not yet clear. An evaluation of the Business Bank's activities in 2014 showed that 10% supported science and technology, and while it is operating in all UK regions, 40% of activities were concentrated in the South. An evaluation of the overall effectiveness of direct and indirect schemes combined seems necessary. In terms of public funding, the plan to invest €8b (£5.9b) 2016-2021 is a positive development, since public research funding often supports increases in private R&D funding.

Challenge 2: **R&D specialisation and commercialising public research**

Description

As an increasing number of countries drive forward innovation and science, targeting resources on areas of national and regional R&D specialisation can optimise value from strong and/or emerging R&D areas. The UK increasingly competes on the basis of its innovation capacity, not least because its comparative advantage is disproportionately derived from R&D and innovation intensive sectors, as illustrated below (BIS, 2014a). This shows the strong R&D component of areas such as services, pharmaceuticals, ICT, transport, as well as financial and business services. At the same time, the UK shows weak investment in non-R&D innovation which may contribute to weaker productivity growth in the economy. A greater targeting of investments and prioritising key areas could increase economic growth and societal well-being.

Figure 1: UK's revealed comparative advantage in selected sectors in 2011



Note: * R&D intensive sectors; ** Innovation intensive sectors
Source: BIS analysis (calculations based on UNCOMTRADE and IMF data; BIS (2011) Figures 34 and 35)

While the UK's basic science is strong in a number of areas, commercialisation of publicly funded research into commercial products, process and services remains an important focus for improvement. Concerns over the translation of the results of publicly supported R&D into commercial products, processes and services – "smart, co-ordinated, dynamic

and fluid partnerships" are required to enable "the institutions which create knowledge and the organisations which draw upon these developments to work together seamlessly" (BIS, 2014a).

Policy response

While UK science funding is mostly allocated through a bottom-up approach, assessed for excellence, targeting priority areas is gaining importance with limited resources allocated towards strategic fields of economic, environmental and societal importance. The Industrial Strategy put forward by the Government sets out 11 sectors in which to develop strategic partnerships with industry. They are the UK's leading sectors (or with lead potential) and which may have the potential to stimulate growth throughout the economy. Significant initiatives in these areas include the co-funded Aerospace Technology Institute, Automotive Advanced Propulsion Centre, and the Centres for Agricultural Innovation and an Agri-Tech Catalyst. These initiatives may help to improve the comparative advantages of R&D in these key sectors. The Industrial Strategy also frames government investment in eight cross-platform emerging technologies in which the UK has the depth of research expertise and business capability to develop its potential, with a budget of some €810m (£600m) in 2012. At regional level, the Local Enterprise Partnerships (LEPs), under the Government's 2014 innovation strategy, could play a stronger facilitating role in processes for the definition of R&I priorities through the prominence of the concept of 'place' and new regional innovation plans. The devolved administrations are in the lead of developing smart specialisation plans as a way to boost investment across regions, notably by R&D industries. To improve commercialization an extensive range of measures have evolved. Recent additions to this range include new cluster-type measures (such as 'Catapults', Knowledge and Innovation Centres and Research and Innovation Campuses), alongside incentives that address a range of actors, through different modalities to sustain collaboration for innovation. The longevity of much of this comprehensive and complementary set of measures strongly suggests its success (based on an extensive process of review and evaluation). Moreover, the Research Councils support substantial translational activity including follow-on funding and research and innovation campuses, together with support for university-business collaboration to help ensure the future uptake of research outputs: for example, the launch of the Gateway to Research in 2013 is aimed at the encouragement of university-business connections.

Assessment

According to the 2014 evaluation of the Industrial Strategy, there is confidence in the approach to working with industry on priority fields, although impact may only be seen in a decade. It cites initial successes in terms of funding allocated to the plan despite fiscal constraints and funding from industry which matches this investment. In the medium term, in important industry sectors like ICT and services with a high degree of R&D capacity, the benefits from the EU's recent Digital Single Market strategy could be significant. It is too early to assess the innovation strategy and impact of the LEPs. R&I is a key element of the 'Fixing the Foundations' plan, centring policy efforts on increasing productivity in the UK economy. While the UK has developed smart specialization plans, coordination and engagement in the processes could be improved and the national action plan's R&I components need to be developed to meet the objectives. More generally for the UK, a longer term public R&D investment plan would support the UK's goal of raising productivity levels and competitiveness. Longstanding knowledge exchange measures have received positive evaluations. The newer Catapult centres received a positive review in 2010, and again in 2014, the latter recommending investments based on thorough reviews. Further impetus for this area comes with the Dowling review of university-business collaborations in July 2015, which pointed out weaknesses between sectors, institutions and companies despite a generally positive record on this measure.

Challenge 3: **Boosting support to scale-ups, including innovative, high-growth companies**

Description

While the UK performs well overall in many composite innovation rankings, the efficiency of UK R&D inputs to outputs puts it in 10th place, despite a strong improvement since 2014 (placed 18th) (Edquist & Zabala-Iturriagagoitia, 2015). It registers weaker performance on SMEs and innovation, with average-to-low levels of new-to-market innovations, and low numbers of innovative SMEs, ranking 23rd for SMEs introducing product or process innovations (IUS 2015). Supporting the scale-up of high growth enterprises, including SMEs is gaining attention in the UK, along with improving innovation in the public sector through procurement, as part of policy efforts to address the broader problem of weak productivity. At the same time, the UK has a relatively strong share of exports of medium and high-tech products and in services and a high share of exports in knowledge intensive services.

Policy response

Besides tax incentives for SMEs, a number of measures aimed at the creation of start-ups and spin-offs also exist under the broad challenge of increasing the transfer of research results into economic outputs. Various initiatives also make specific provisions to attract SMEs into research consortia involving a range of knowledge sector and private sector actors and also into cluster-type initiatives. Overall, SME support is delivered through a multimodal and flexible range of support measures addressing the spectrum of SME needs at both national and targeted regional/local levels, and with a recent focus on reducing the bureaucratic barriers faced by small companies in accessing such support. Schemes include the UK Innovation Investment Fund (IIF); Enterprise Finance Guarantee: extended Autumn 2014 to provide c. €625m of new funding by 2015/16; Venture Capital Trusts; Business Angel Co-Investment Fund (€58m); Enterprise Investment Scheme and Seed Enterprise Investment Scheme; Bank-led Business Growth Fund of €2.9b to fund high growth companies. To increase innovation in companies and support SMEs, the Government's 2013 Budget announced an expansion of the Small Business Research Initiative (SBRI), which seeks to drive innovation through public procurement. This expansion involved setting specific targets for key departments with the expectation that the value of procurement contracts via SBRI would increase from €54m (£40 million) in 2012-13 to over €270m (£200 million) in 2014-15. Furthermore, the assessment of weak labour productivity outlined by the new Government through its summer 2015 plan 'Fixing the Foundations' included a commitment to supporting the scale-up of high growth companies. UK SMEs perform particularly well in bidding for the EU R&I programme SME instrument which supports European collaboration and market access.

Assessment

A 2012 review of the Business Growth Fund suggests a slight increase in uptake annually. The IIF also received a positive review in 2012. The SBRI is appropriate to the goal of investigating potential demand-led innovation from Government. An evaluation has been recently completed but there are already some successes - since 2009 it has delivered 215 competitions from 70 public bodies and resulted in 1,850 contracts. The recent productivity plan seems to represent a major part of the Government’s priorities, having been delivered by the Chancellor and the Minister for Business, Innovation and Skills. A robust overall monitoring and evaluation framework, along with a robust data and evidence base is needed to support policy implementation.

Challenge 4: **Ensuring the future supply of human resources in S&T**

Description

Addressing the future skill needs of industry, particularly in regard to high-end and complementary skills sets is a challenge for the UK. Recent analysis indicates that demand for high-level skills will rise in coming years with an additional 2 million jobs projected by 2022 (further exacerbated by an increasingly ageing workforce), and the share of employment in almost all occupations shifting in favour of higher level qualifications.

Policy response

Policies aimed at ensuring the future supply of human resources in S&T (HRST) include continuing support for research training (through the Research Councils) although universities have seen modest cutbacks in their funding for teaching activities - the government will reduce the teaching grant by £120m in cash terms by 2019 to 2020, but allow funding for high cost subjects to be protected in real terms. The shortfall, to be addressed by the increase (and the removal, in 2014, of the cap on student fees that Higher Education Institutions could charge) appears to have been less than initially feared and student enrolments appear to be increasing after a slight decline. Furthermore, in 2015, the Government removed the 'cap' on student numbers which had previously limited the numbers of students that universities were able to recruit. In terms of skills provision for industry, it could be argued that further structural change is required and that the emphasis placed on the Higher Education sector as the leading supplier of skilled workers is inappropriate, since the lack of a strong vocational/technical training sector remains an issue. However, the Government has announced additional resources for Science Technology, Engineering and Maths (STEM) education, the expansion of the Higher Apprenticeships scheme and the setting up of National Colleges in key STEM sectors such as Digital Skills, Wind Energy, and Advanced Manufacturing. There are a number of schemes to respond to the skills gap, e.g. an existing range of research training through Research Councils (including CASE awards), teaching/research clusters and centres of excellence; continuing review of training and teaching needs addressed by HE funding bodies and research councils; support for early career post-doctoral research and career development fellowships through Royal Societies, Research Councils and British Academy; increased support for Apprenticeships schemes in 2011 – with further expansion announced in the 2014 Plan for Growth.

Assessment

The policies and schemes address both generic and more specific employee skills needs, although there is still demand from employers for additional skills sets. Reviews and evaluations ensure delivery of appropriately trained researchers into the research base and business. The Royal Society support schemes for excellent researchers addresses the need to maintain quality as a lynchpin of research support. Support for apprenticeships addresses the absence of adequate pathways for lower level technical skills provision with skills addressed at several levels. The responses to the Richard Review of Apprenticeships published in November 2012 appear to be working well; the Government adopted a number of recommendations in spring 2013, and plans to introduce further Higher Apprenticeships.

1. Overview of the R&I system

1.1 Introduction

The UK has the third largest population among the EU Member States, with 12.75% (64.8m) of the EU-28 total population of 508.2m in 2014[2]. In 2014, it had a per capita GDP of €34,900 compared to an EU-28 average of €27,400[3]. Since 2012, GDP has grown by 8.9% from €2,041,491m to €2,222,912m in 2014: as seen from Table 1, year on year real GDP growth rate has been steadily accelerating since 2012.

In terms of other macroeconomic indicators, government debt has fallen from -8.3% of GDP to -5.7%, a level that has remained constant in 2013 and 2014, although as noted above, GDP has risen significantly, thus in absolute terms government debt will have continued to decrease. Employment figures continue to improve, with only 6.1% of the labour force unemployed, compared to an EU-28 average of 10.2%. Although employment in high- and medium-high-technology manufacturing sectors as a share of total employment has fallen slightly since 2012 and stood at 3.6% compared with an EU-28 average of 5.7% in 2014, employment in knowledge-intensive service sectors as a share of total employment has been relatively stable at around 48.7%, above that of the EU-28 average of 39.8% in 2014. These figures probably reflect the structure of the UK economy in which the service sector (including knowledge intensive services) plays a larger role than in many EU Member States.

In 2013, UK GERD stood at €32,783m (around 12% of total EU-28 GERD), slightly up on 2012[4], a growth rate of 3.9%, compared to an EU-28 growth rate of 5.3%. As a percentage of GDP, UK GERD was at 1.72% in 2014 compared to an EU average of 2.03%. UK GERD per capita stood at €595.9 in 2014, above the EU-28 average of €558.4. From 2011 to 2013, UK BERD has risen (consistently) by 5.4% to €21,149m (contributing about 12.1% of EU-28 BERD). This growth rate compares to a 6.3% increase in EU-28 BERD.

In its ten-year Strategic Innovation and Investment Framework, 2004-2014 (BIS, 2011) the UK expressed the ambition to reach a ratio of GERD to GDP of 2.5% by 2014. While the economic recession reduced the probability of this being achieved, recent figures have shown a better than anticipated growth for the UK economy although the ratio remains around 1.72%[5]. The latest strategy document (Our plan for growth (HM Treasury and BIS, 2014) does not set out a specific target.

The Business Enterprise sector is the largest contributor to GERD, at 64.5%. The HE sector performs a further 26% and the Government sector 7% (although the government supports a significant proportion of HE R&D activities). The private not-for-profit sector performs the remaining 2%. In 2013, government funding on R&D amounted to £3,214m (c. €4,018m), while business funding on R&D was £13,343m (c €16,679m). Higher Education Institutes (largely comprising universities) form the largest performer of research in the public sector, performing R&D to the value of £7,628m (c €9,535m) in 2013. While there are no specific figures for PROs, total GERD by the government sector as a performer of R&D amounted to £1,467m (c €1,834m) in the same period[6].

---

[2] http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tps00001&plugin=1

[3] http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tec00001&plugin=1

[4] http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do

[5] However, 'Our plan for growth: Science and innovation' (HM Treasury, BIS, 2014) states "in the UK, total investment was 1.7% of GDP in 2012, and this level has been stable since the early 1990s" (p10) while later it notes "total UK investment in R&D has been stable and relatively low at around 1.8% of GDP since the early 1990s" (p51). Both figures are slightly at odds with Eurostat data.

[6] http://www.ons.gov.uk/ons/rel/rdit1/gross-domestic-expenditure-on-research-and-development/2013/tsd-gerd-2013.html

In 2013, of a total business expenditure on R&D of £18,448m (c €23,060m), over half - £9,925m (c €12,403m) - was funded by non-UK owned companies[7]. Of this total expenditure, SMEs (firms with fewer than 250 employees) contributed £4,234m (c €5,293m) or 23%.

Table 1: Main R&I indicators 2012-2014

Indicator	**2012**	**2013**	**2014**	**EU average**
GDP per capita	€32,200	€31,900	€34,900	€27,400 (2014)
GDP growth rate %	1.2%	2.2%	2.9%	1.4% (2014)
Budget deficit as % of public budget	85.3%	86.2%	88.2%	86.8%
Government debt as % of GDP	-8.3%	-5.7%	-5.7%	-3.0%
Unemployment rate as percentage of the labour force	7.9%	7.6%	6.1%	10.2%
GERD in €m	33,304	33,999	n/a	283,009.388 (total EU-28)
GERD as % of GDP	1.63%	1.69%	1.72%	2.03%
GERD (EUR per capita)	524.5	532	595.9	558.4
Employment in high- and medium-high-technology manufacturing sectors as share of total employment	3.8	3.7	3.6	5.7 (2014)
Employment in knowledge-intensive service sectors as share of total employment	48.7	48.3	48.7	39.8 (2014)
Turnover from innovation as % of total turnover	14.1	n.a.	n.a.	11.9 (2012)
Value added of manufacturing as share of total value added	17.3	17.0	n.a.	26.2% (2012)
Value added of high tech manufacturing as share of total value added	1.8	1.6	n.a.	2.5% (2012)

Source: Eurostat, 2015.

[7] http://www.ons.gov.uk/ons/dcp171778_385959.pdf (Table 22)

1.2 Structure of the national research and innovation system and its governance

1.2.1 Main features of the R&I system

The UK research system is largely centralised, although regional autonomy for innovation policy has been increased in recent years. The Devolved Administrations of Scotland, Wales and Northern Ireland have responsibility for aspects of health and education funding. Block funding for higher education institutes is provided by separate higher education funding councils (or similar bodies) in each country, although the bulk of research funding across the UK comes via the Research Councils which have a UK-wide remit. At the regional level in England, responsibility for innovation support has been assumed by Innovate UK (formerly the Technology Strategy Board) following the abolition of the Regional Development Agencies in 2011, although Innovate UK also has a UK-wide remit in providing innovation support. At the local level in England, some innovation policy and related activities are coordinated by Local Economic Partnerships. These are consortia of regional actors such as key businesses and councils and have the remit to determine local economic priorities and lead economic growth and job creation within the local area. As of October 2013 there were 39 LEPs in place[8]. The Devolved Administrations may operate versions of UK innovation support initiatives according to their specific strategic needs (Cunningham, 2015). Examples of such schemes include SMART Scotland and SMART Cymru and SMARTExpertise in Wales.

1.2.2 Governance

In a General Election held in May 2015, the Conservative party, which had previously governed in a coalition with the Liberal-Democrat party, gained an overall majority - the first time a Conservative majority government had been elected since the 1992 General Election. The change of government saw some shifts in ministerial responsibilities but no changes to the overall governance structure. As noted in the previous report in this series (Cunningham, 2015), a referendum on Scottish independence, held in September 2014, resulted in an approximately 10% majority vote to remain in the United Kingdom. As a result of political pledges made in the run-up to the referendum, there are likely to be shifts towards greater devolution of economic and political power among the constituent parts of the UK. While the full implications of these pledges will not be known for some time, the fact that the Scottish National Party returned the third largest number of seats in parliament, with an overwhelming majority in the Scottish Parliament may accelerate the rate of devolutionary changes, which could well have implications for the overall UK science system.

At the broad policy level, the change of Government and the (then) pending Comprehensive Spending Review 2015 have meant that few new major policy announcements or publications have been made during early 2015. Key policy publications for 2014 were produced in December of that year, thus it is anticipated that any new publications and announcements will fall around the same time this year.

Overall government spending levels in the UK are set through the Comprehensive Spending Review (CSR) process carried out by HM Treasury. The aim of the CSR is to set clear expenditure limits and, to define the key improvements that government will deliver with these resources. Each CSR, which usually takes place every three years, focus on each government department's spending requirements from a zero base (i.e. without reference to past plans or, initially, current expenditure). The latest CSR reported in autumn 2015.

[8] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/252793/bis-11-768-local-enterprise-partnerships-boundary-map-august-2013.pdf

The Department for Business, Innovation and Skills (BIS) plays the lead executive role in research issues, and is the home of the Government Office for Science (GO-Science), headed by the Government's Chief Scientific Adviser (CSA). GO-Science plays the lead role in improving the quality of science in the UK. The CSA reports directly to the Prime Minister and the Cabinet. The CSA also chairs the principal high-level national policy making and coordination body, the Council for Science and Technology (CST), which in turn draws on policy advice from a range of bodies both within and outside the Government structure, including dedicated committees in both the upper and lower houses of Parliament. High-level UK science policy making also places particular emphasis on the use of systemic reviews and evaluations (Cunningham, 2015).

The CSR process confirms the size of the Science Budget (as a distinct line of BIS expenditure) and the Research Councils, HEFCE, the UK Space Agency and the National Academies are required to set out delivery plans for the CSR period, taking account of BIS priorities for science and research funding. Ministers' decisions on the allocations of science and research funding take account of the extent to which the Delivery Plans meet BIS priorities and also take account of views expressed in a wide-ranging consultation process on science spending.

BIS is the major provider of research funds for the public sector and is also responsible for the allocation of the UK Science Budget via the Research Councils and, to a lesser degree, the Royal Society and Royal Academy of Engineering. The Research Councils, which in turn support R&D and research training both in Higher Education Institutions (HEIs) and their own institutes, provide research grants for programmes, projects and research centres. In addition, some of the Councils maintain their own research facilities in the UK and abroad for university researchers. Substantial funds are also allocated in the form of block grants to UK universities (see Section 3.4.1) from the Higher Education Funding Councils and their equivalents in the devolved administrations (Cunningham, 2015).

The UK is recognised internationally as having a well-developed culture of evaluation. The underlying performance monitoring system of PSAs put in place by the Treasury serves as a broader mechanism for performance measurement and for monitoring progress against targets. Failure to meet PSAs can affect future budgetary allocations (allocated through the CSR); hence it is in the clear interest of ministry officials to ensure that their policies are designed to effectively and efficiently meet these targets.

Evaluation has become a strongly entrenched policy tool within BIS and the Research Councils. Numerous programmes (either singly or as groups of related programmes) have been and are subject to evaluation, either by dedicated bodies within the funding agencies or by external consultancies. A range of stakeholders may be consulted on the technical and operational details of policy measures, depending on the type of measure being designed. For example, fiscal measures will involve major inputs from HM Treasury and the Inland Revenue, while technology transfer measures will take account of the views of business representatives, universities, intermediary organisations, employers' representatives, etc. The way in which this involvement is handled will vary on a case by case basis (Cunningham and Karakasidou, 2009).

Since BIS has oversight of the core range of innovation support policies implemented (at least in England), responsibility for oversight of the evaluation of these innovation support instruments now also resides with BIS, with supporting interest from HM Treasury (the UK's ministry of finance) and the National Audit Office, the Government's financial 'watch dog'.

Generally, most evaluations are performed on an interim basis as the primary aim is to gain lessons and feedback on programme performance with a view to making any appropriate changes to their structure and management. Few programmes tend to have a restricted lifetime, although these are generally subject to ex post evaluation in order to develop 'evidence-based' policy making. As a general rule of thumb, the evaluation budget is around 0.5-1.0% of the total programme budget but this may be higher for

smaller programmes (to meet minimum budgetary requirements) and vice versa (as evaluations of large, expensive programmes do not necessarily require higher budgets).

In the definition of research priorities, the Government ensures that it takes the views of a large range of stakeholders (including the private sector) into account. This may be done through foresight exercises (which are now more specific than the broad Foresight exercises of the 1990s), through 'horizon scanning' activities or through invited consultations on a range of documents, such as draft strategies. The Government also consults extensively with a range of stakeholders in the preparation of its STI policies - an example being the recent consultation in advance of the publication of the new 'Our Plan for Growth in December 2014 and the accompanying evidence paper.

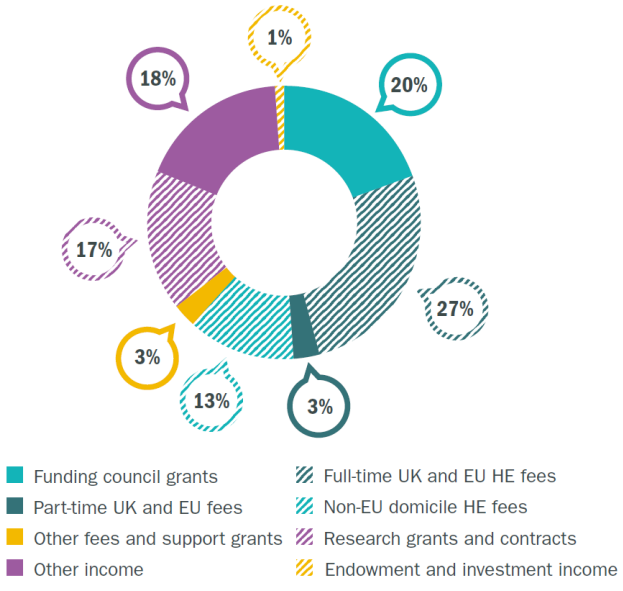
The Government adopts an open approach to the publication of the majority of its evaluation activities. Many government commissioned evaluations may be located on the Inside Government website, while HM Treasury produces guidelines on evaluation and assessment practice across Government, for example in its Green Book[9] .

1.2.3 Research performers

The Higher Education sector forms the largest performer of research in the UK. As of August 2014, there were 160 Higher Education Institutions (HEIs) in the UK of which 115 were universities (this includes federal universities such as those of London and Wales, which are counted as a single entity). These employ over 128,000 full time academic staff (2013/14). They vary considerably in size from around 300 students to the University of Manchester with over 38,000 students[10].

All universities undertake a range of teaching, research and third mission activities, although the balance of these will vary between institutions: some universities are 'research intensive, while others are more teaching oriented and all undertake a range of collaborative activities with their local communities which will vary greatly in nature. As an illustration, the following figure shows the proportion of the sources contributing to a total of £30.7b (c €39.4b) income to all UK HEIs in 2013-14.

Figure 2: UK Higher Education in Facts and Figures, 2015



Source: HESA

[9] https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent
[10] https://www.hesa.ac.uk/index.php?option=com_content&view=article&id=1898&Itemid=634

Due to successive governance changes, many public sector institutes and laboratories have undergone a shift from contractor status, through 'arms-length' executive agency status to full privatisation. As a result, several reside either partly or wholly in the private sector, under a variety of, often quite complex, contractual arrangements. This has led to a shift in the relationship between these agencies and their former parent departments or ministries and the latter have largely become customers (rather than sponsors) of the research and services these agencies undertake. Despite this shift towards privatisation, a number of Government Departments have retained their intramural research capabilities in some form or other, to which can be added the institutes and centres maintained by the Research Councils (Cunningham, 2015).

There were 2.26 million enterprises registered for VAT and/or PAYE (pay-as-you-earn) in March 2014, compared with 2.17m in March 2013, a rise of around 96,000 (4.4%). In 2014, the professional, scientific and technical sector accounted for the largest number of businesses, with 17.5% of all registered enterprises in the UK. Wholesale, retail and repair of motor vehicles formed the second largest sector, with 16% of all enterprises registered. The third largest sector was construction, with 11.8% in 2014 (ONS, 2014). Separate Office of National Statistics (ONS) data from March 2013 indicate that of a total of 1,765,860 registered companies (whose size was known), 85.7% had below 10 employees, 11.7% had 10-49 employees, 2% between 50 and 250 employees and 0.5% above 250 employees.

In broad terms, in 2012, 72% of total UK business R&D spending was on manufacturing activity compared to 25% on services activity. Some £12.2bn (€15.25bn) was spent by UK businesses on manufacturing R&D in the UK in 2012. The largest expenditure was by the chemicals product group at £4.7b (€5.88b), 32% of the total, of which Pharmaceuticals forms the largest contributor – see below).

According to ONS data, in 2013 the business enterprise sector accounted for £18.4b (c. €23b) of expenditure, representing 63% of total expenditure on R&D and 1.1% of GDP. This represented an increase of 6% in current prices from £17.5bn (c. €21.9b) in 2012 (and a larger increase in terms of real prices). Data compiled from the 400 largest business R&D spenders indicates that the product groups with the largest R&D expenditure in 2013 were:

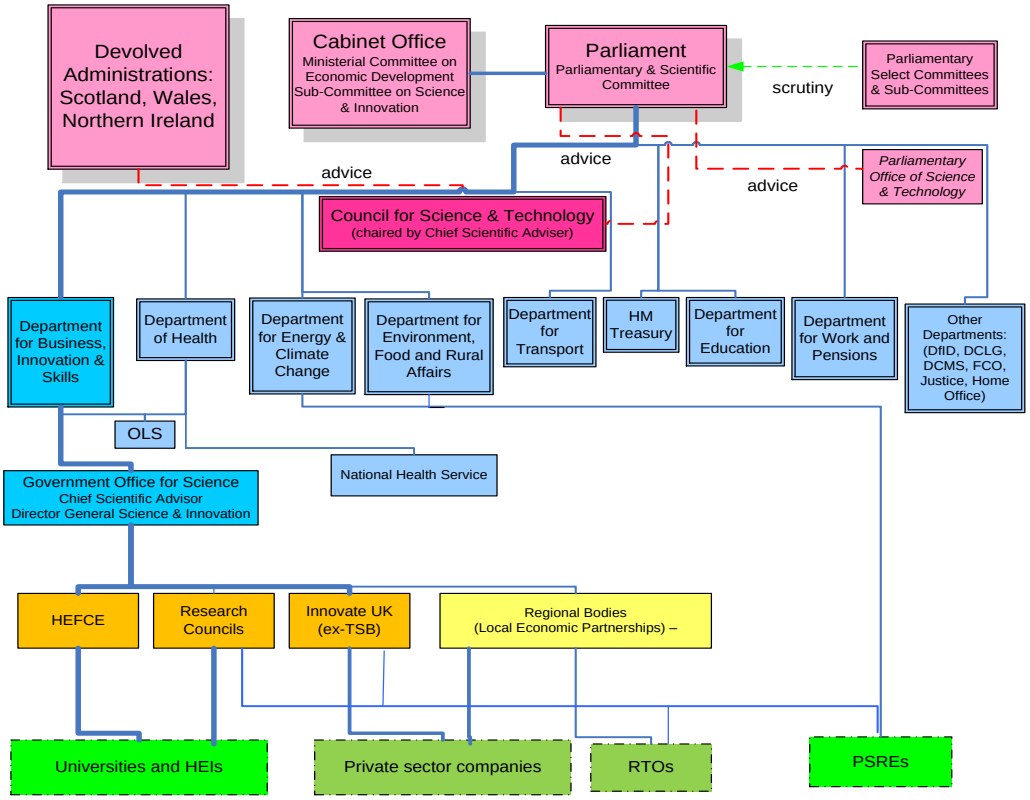
- Pharmaceuticals (£4.1b: c. €5.13b)
- Motor vehicles and parts (£2.06b: c. €2.57b)
- Computer programming and information service activities (£2.02b: c. €2.52b)
- Aerospace (£1.66b: c. €2.08b)
- Machinery and equipment (£1.04b: c. €1.3b)
- Miscellaneous business activities and Technical testing analysis (£0.97b: c. €1.21b).

The Research and Development Services product group exhibited the largest overall increase (53%) in expenditure since 2012, increasing by £322m (c €402m) to £929m (c €1.16b) in 2013 in current prices, while the Miscellaneous business activities product group increased by 44%, from £673m (c €841m) to £972m (c €1.22b). The largest increase in an individual product group was shown by the Motor vehicles and parts product group, which rose, for the second year in succession, to £2.0b (c €2.5b) in 2013 – an increase of 17% over 2012. This product group now makes up 11% of total expenditure on R&D performed in UK businesses in 2013 and appears to derive from resurgence in British car design and engineering. Although the Pharmaceuticals product group has remained the largest contributor to the total expenditure on business R&D in the UK since 1988, it experienced a second successive year of decline: between 2011 and 2012, R&D expenditure in Pharmaceuticals fell by 15% and by a further 3% between 2012 and 2013 (ONS, 2015[11]).

[11] Available at http://www.ons.gov.uk/ons/dcp171778_385959.pdf

The presence of foreign owned business R&D facilities has been a long-standing feature of the UK innovation landscape. For the first time, in 2011, R&D expenditure in the UK by foreign owned businesses exceeded that by UK owned businesses, reaching 51% of the total. This trend has continued and, in 2013, expenditure on R&D in the UK by UK owned businesses increased by 4% from 2012 and now constitutes 54% of total expenditure (ONS, 2015).

Figure 3: UK R&I system system



Key:
DCLG: Department for Communities & Local Government
DCMS: Department for Culture, Media & Sport
DfID: Department for International Development
FCO: Foreign & Commonwealth Office
HEFCE: Higher Education Funding Council
HEIs: Higher Education Institutes
OLS: Office of Life Sciences
PSREs: Public Sector Research Establishments
RTOs: Research & Technology Organisations

Political level and high level cross cutting policy level
Ministry mission centered coordination
R&D funding allocation
Research Performers

Source*:* Cunningham, 2015

2. Recent Developments in Research and Innovation Policy and systems

2.1 National R&I strategy

In terms of strategic direction, the long-term (ten year) policy for UK science and innovation investment is set out in 'Our Plan for Growth: science and innovation' (HM Treasury and BIS, 2014), published in December 2014. Since the UK Government takes a holistic view of innovation, the Plan integrates research and innovation and has the ambition for the UK "to be the best place in the world for science and business". It comprises six elements:

1. Deciding priorities (a process supported by the Eight Great Technologies and the Industrial Strategy)
2. Nurturing scientific talent
3. Investing in our scientific infrastructure
4. Supporting research
5. Catalysing innovation
6. Participating in global science and innovation.

Underpinning these elements are five themes, perceived as critical to the success of the Plan:

- the importance of achieving excellence
- the imperative to operate at a quickening pace and show agility to seize new opportunities
- the need to accommodate and foster higher levels of collaboration between disciplines, sectors, institutions, people and countries
- the need to recognise the importance of place, where people and organisations benefit from mutual proximity
- the modern demand for openness and engagement with the world (HM Treasury, 2014).

The Plan for Growth does not explicitly address or refer to EU priorities but does note that the UK is already the top beneficiary from the EU Framework Programme, particularly funding received via the European Research Council (ERC), and highlights the need to build on this success and to increase SME access to Horizon 2020 funding. It also notes that the UK should seek to influence the new EU Commission and the European Parliament on the future of science, innovation and research policy, something in which the UK is already active, for example in driving the development of the ERA roadmap and, by setting out the priorities for deepening the ERA as a single market for research and knowledge (by mid-2015).

As in previous cases, and following normal Government practice, the new strategy document was preceded by a number of reviews and consultations, for example "Insights from international benchmarking of the UK science and innovation system" (BIS, 2014a). It was also accompanied by an Evidence Paper which provides background information on the underpinning rationale for the new strategy (BIS, 2014b). These examined a range of relevant conditions such as strengths and weaknesses, emerging opportunities and potential market opportunities. The overall positioning and performance of the UK in terms of innovation was also presented in the BIS Annual Innovation Report, the latest produced in March 2014 (BIS, 2014c). This draws on various sources, such as the international benchmarking report noted above.

With regard to the Devolved Administrations, the Scottish Government is responsible for all devolved issues such as education and health. Its objectives and priorities for STI issues are given in the most recent policy paper, Science for Scotland (2008). Policy advice for science, technology and innovation is provided by the Scottish Science Advisory Council (SSAC). The position of Chief Scientific Adviser for Scotland has been vacant since December 2014. Although science policy and funding is not devolved in

Wales, in 2006, the Welsh Assembly published "A Science Policy for Wales?" outlining its strategic vision for science, engineering and technology. Its three priorities were: health/life sciences, the low carbon economy and sustainable economic and social regeneration. A new policy, Science for Wales, was published in early 2012 and Annual Reports on the delivery of the strategy have been produced, the latest in June 2015. In March 2012, the Northern Ireland Executive published an Economic Strategy, which includes, *inter alia*, the objectives of stimulating innovation, R&D and creativity, improving skills and employability and encouraging business growth [12]. This was accompanied by a Comprehensive Action Plan which sets out a more detailed list of commitments to be delivered by NI Departments[13].

Finally, at the local level, the Government has invited universities, cities, Local Enterprise Partnerships and business to work with it to map the strengths of different regions through a series of science and innovation audits. The aim is to build on different regions' strengths and to maximise the economic impact from the UK's research base[14].

2.2 R&I policy initiatives

Since research and innovation are developed under an holistic strategy, the policies and associated measures put in place follow an integrated and coordinated approach. Hence, in the UK, public action in all relevant policy areas is designed and implemented in a strategic, coherent and integrated framework and tailored to foster innovation and strengthen the knowledge base and fundamental research.

The most recent key R&I policy announcements made in Our Plan for Growth are given below (these also include investments in research infrastructures):

Under the topic of 'Nurturing scientific talent', the Government announced that it would: increase the quantity and quality of STEM teachers through £67m (c. €86m) of new programmes, including training and recruiting new maths and physics teachers and up-skilling non-specialist teachers. It also aimed to deliver more Higher Apprenticeships in key areas and to establish National Colleges in key STEM sectors such as Digital Skills, Wind Energy, and Advanced Manufacturing. New support would be introduced for those wishing to attain a postgraduate qualification (income contingent loans for the under 30s). Finally, the Government would launch a dedicated platform with advice and information, to match female STEM graduates to jobs in industry to facilitate their return following career breaks.

Concerning 'Investing in our scientific infrastructure', it was announced that, overall £5.9bn (c. €7.5bn) will be committed to science capital from 2016 to 2021, including £2.9bn (c. €3.7bn) towards scientific grand challenges. New projects include:

- £235m (c. €301m) for the Sir Henry Royce Institute for advanced materials
- £113m (c. €145m) towards big data at the Hartree Centre, Daresbury
- £95m (c. €122m) for European Space Agency programmes
- £31m (c. £40m) for a new Energy Security and Innovation Observing System
- £60m (c. €77m) to extend the capabilities of the National Nuclear Users Facility
- £20m (c. €26m) towards a centre for ageing science and innovation in Newcastle

Further identified capital proposals will be subject to a process of international peer review and a 'capital agility fund' of £900m (c. €1.15bn) has been created to respond to grand challenges as they emerge. In addition, £3bn (c. €3.8bn) will be provided to support individual research projects, research in institutional laboratories, and to provide funding for international subscriptions. Over half of this will be subject to competition.

---

[12] Northern Ireland Executive, 2012.
[13] http://www.northernireland.gov.uk/nies-comprehensive-action-plan-130312.docx
[14] HM Treasury 2015.

In terms of 'supporting research', a number of reviews have been set in place:

- An assessment (by HEFCE) of HEIs' performance in knowledge exchange activities to identify examples of good practice.
- A review of the Research Councils (by Sir Paul Nurse) in order to evolve their support for research in the most effective ways.
- A review by HEFCE to consider how to reward open data as part as part of the future REF assessments subject to the evaluation of the REF 2014 review.
- An examination of R&D spending by Government departments to ensure it is properly prioritised against other capital investment spending.
- A review into Business-University research collaboration by Professor Dame Ann Dowling (published July 2015).

Announcements concerning the element 'Catalysing innovation' include: continued expansion of the Catapult network, with two more Catapults (Energy Systems and Precision Medicine) due to open in 2015; a further £61m (c. €78m) will be provided to the High Value Manufacturing Catapult to meet increasing demand and provide outreach and technical support to SMEs, while an additional £28m (c. €36m) will fund a new National Formulation Centre as part of the High Value Manufacturing Catapult. There will also be additional expansion of the network if the financial recovery allows. As noted in the 2014 Autumn Statement, there is a new commitment of £400m (c. €513m) over three years to extend the British Business Bank's flagship venture capital programme, Enterprise Capital Funds. An additional £9m (c. €11.5m) will be provided towards driverless car test beds.

Finally, regarding 'participating in global science and innovation', continued support (£375m – c. €480m, over five years) will be provided for the Newton Fund to support the development of scientific excellence and build scientific partnerships. UK participation in the European Research Area, the G7, G7+5, G20 and its Presidency of the EU in 2017 will be utilised to demonstrate UK leadership on topics such as open access and infrastructure. Further support will be offered to UK universities and research institutions to access some of the research elements of the $140bn (c. €103.7bn[15]) international aid funding from multinational banks, UN agencies and other donors. The UK Government has identified 'eight great technologies' (to which two more have been added) which are considered to be key to further growth in the UK economy. These are:

1. the big data revolution and energy-efficient computing;
2. satellites and commercial applications of space;
3. robotics and autonomous systems;
4. life sciences, genomics and synthetic biology;
5. regenerative medicine;
6. agri-science;
7. advanced materials and nanotechnology;
8. energy and its storage;
9. quantum technologies;
10. the internet of things.

In addition to the above announced developments, a number of further developments have taken place. These include:

- A £120m (c €160m) national network of university-led Quantum Technology (QT) Hubs was launched in November 2014. These are located in Birmingham, Glasgow, Oxford and York, but include a further 13 universities and 132 companies and have leveraged over £60m (c €80m) in additional support. In March 2015, the QT Strategic Advisory Board published a quantum technology strategy and £15m (c €20m) was allocated to train the next generation of quantum engineers (BIS, 2015a).

[15] 2014 annual average: $1 = €0.741

- At Budget 2015, £100m (c €133m) was committed by the Government and an identical amount by industry to fund research into autonomous vehicles. The UK is viewed as a world leader in the field of autonomous transport technologies, which will have an estimated global market worth £900b (c €1,125b) by 2025. Over £10m (c €12.5m) has been invested during 2014-15 and 2015-16 (BIS, 2015a).
- An Energy Research Accelerator (ERA) has been established in Birmingham to focus efforts to provide support for research into new ways to reduce energy costs in manufacturing. It will carry out research in cold energy technology, low-carbon mobility and propulsion and energy storage and future urban systems.

The Chancellor of the Exchequer's Autumn Statement, based on the outcome of the 2015 Comprehensive Spending Review contained the following provisions with regard to research and innovation:

- The Science Budget, involving funding of £4.7bn (c. €6.26bn) will be protected in real terms over the period of the existing Parliament and includes a £1.5bn (c. €2bn) new Global Challenges Fund. It was also announced that the outcomes of the Nurse Review (see below) and the HE green paper consultation would be taken into account although no specific details were provided. There was also a commitment to funding aerospace and automotive technologies for 10 years, which would see an additional £1bn (c. €1.3bn) funding for innovation in these sectors.
- By 2019-2020, UK government spending on apprenticeships is set to double in cash terms compared to 2010 to 2011, although this will include income from the new apprenticeship levy funded by businesses. Funding for the core adult skills participation budgets is to be protected in cash terms and five National Colleges will train an estimated 21,000 students by 2020, in core areas of the productivity agenda.
- New financial support will be provide through maintenance loans for part-time HE students, tuition fee loans for higher level skills in Further Education and new loans for postgraduate Master's degrees, reaching £1bn (c. €1.3bn) in 2019-2020 and benefiting around 250,000 students.
- The cap on student numbers has been lifted to allow more young people, particularly from disadvantaged backgrounds, to go to university. While universities have forecast an income growth of £2.3bn (c. 3.1bn) by 2020 through the planned expansion in student numbers, of places for home, EU and international students, the government intends to reduce the teaching grant by £120m (c.€160m) in cash terms by 2019-2020, although funding for high cost subjects is to be protected in real terms.
- Some of the existing grant support schemes offered by Innovate UK grants will be replaced by loan schemes, reaching a figure of around £165m (c. €220m) per year by 2019-2020.
- Finally, BIS will reduce departmental administration spending by a further £100m by 2019-2020 in order to contribute to a wider programme of reform. This will include further reductions in the number of Arm's Length Bodies (ALBs) and, if the Nurse recommendations are implemented, could see the consolidation of the seven UK Research Councils under a central governing authority, with closer central government control.[16]

Evaluations, consultations, foresight exercises

The March 2014 Innovation Report from BIS (BIS, 2014c) contains the latest evidence on innovation activities, compares UK performance against other economies and

[16] https://www.gov.uk/government/news/department-for-business-innovation-and-skills-settlement-at-the-spending-review-2015

highlights policy. It draws on a number of sources, including the results of an International Benchmarking of the UK Science and Innovation System published in January 2014. This provides an extensive review of main relative strengths and weaknesses of the UK's science and innovation system.

In February, 2014, BIS published its report into a review of the balance of competences between the European Union and the United Kingdom in the area of research and development. In terms of funding, the UK was found to perform well in terms of support for R&D from EU sources, although the public sector (particularly researchers from the HE sector) fared better than UK industry. EU programmes were generally found to be useful in mobilising cooperation although they could be overly complex and bureaucratic. There was mixed response to the EU's involvement in defining R&D and innovation policy, with little mention of the EU's Innovation Union as an overarching innovation strategy. The Commission's objective of creating a European Research Area (ERA) was recognised with general support for its objectives, although there were concerns about how far this might encroach on national initiatives and cause unnecessary reporting burdens. In the area of space, the EU's strategic priority-setting was generally seen as useful and UK space policy is closely interwoven with European and international initiatives taken forward in other fora such as the European Space Agency (ESA). There was also a view that the EU did not have a coordinated approach across other policy areas to ensure that these encourage and do not hinder innovation leading to a situation where some legislation from other areas of competence acted as a spur to innovation whilst some hampered it[17].

Following up on the publication of a capital investment framework by the UK Research Councils in 2012, the Government undertook a consultation with the research community and other stakeholders to identify priorities for investment to 2021. This included both institutional and regional based infrastructures but also where the UK could collaborate on an international basis, either as a host or part funding a facility based elsewhere. The outcome of the consultation was published by BIS in December 2014[18] and contains a roadmap for capital infrastructure investment through until 2021. The 2014 Science and Innovation Strategy (BIS, 2014c) referred to the consultation and noted that £5.9b (c. €7.9b) has been allocated to science capital from 2016 to 2021, marking the "longest commitment to science capital in decades".

In May 2014, the leading technology entrepreneur Hermann Hauser published the results of his examination of the UK network of elite technology and innovation centres (Catapults)[19]. Essentially, the review called for continued Government commitment, including increased funding, to the Catapults and to their expansion (to a target population of 30 by 2030), while the catapults should seek further integration with regional innovation actors and develop improved sets of key performance indicators by which their progress may be assessed.

In November, 2014, the UK Space Agency produced the outcomes of a review and evaluation of the National Space Technology Programme (UK Space Agency, 2014). The report examined the Space Technology Programme funding portfolio which delivers support for the growth of the space sector. Overall, the programme was found to be very successful although the report includes recommendations for areas where improvements can be made.

The final outcomes of the latest Research Excellence Framework (REF) were published in December 2014. Conducted by the Higher Education Funding Councils, REF is a peer assessment of the quality of UK universities' research in all areas. A total of 154 UK

[17] HM Government, 2014.
[18] Outcome of consultation: Creating the future: a 2020 vision for science and research - government response to consultation on proposals for long-term capital investment in science and research: https://www.gov.uk/government/consultations/science-and-research-proposals-for-long-term-capital-investment
[19] https://www.gov.uk/government/publications/catapult-centres-hauser-review-recommendations

institutions made submissions in 36 subject based units of assessment, with outcomes demonstrating that the quality of research in the UK has continued to improve since the last exercise took place in 2008. In research outputs, 22% of research was assessed as world-leading, up from 14% in 2008, and a further 50% of research was rated internationally excellent, up from 37% in 2008. For research impacts, 44% were judged outstanding by over 250 external users of research, working jointly with the academic panel members, with a further 40% judged very considerable (BIS, 2015a).

The 2014 Science and Innovation Strategy (BIS, 2014d) announced that an independent review would be carried out into Business-University research collaboration by Professor Dame Ann Dowling. The review, published in July 2015[20], makes recommendations for BIS on how government can: support relationships between UK businesses and the UK's world-leading university researchers by reducing complexity and foster and support relationships between researchers and business, particularly for smaller firms looking to innovate (BIS, 2015b).

The main conclusions were that the plethora of Government schemes aiming to facilitate business-industry research collaboration requires simplification. This could be achieved both by reducing the overall number of schemes and by simplifying the interface between the user and the scheme. There should also be a change in UK universities to increase the perception by academics that their university supports and rewards industrial collaboration. The report noted a gap in the market to encourage academia-industry research partnerships to grow, particularly in helping existing short-term, project-based collaborations to evolve into longer term partnerships focused on use-inspired research – here it proposes a new 'Awards for Collaborative Excellence' scheme to offer pump-priming to enable strong relationships between academia and industry to develop into group collaborations with critical mass, substantial industry funding and a long-term horizon[21].

In March 2015, RCUK published the outcome of a comprehensive, evidence-based review of the effectiveness and impact of its Open Access policy led by Professor Sir Bob Burgess, former University of Leicester Vice-Chancellor. The review panel made a number of recommendations to help improve some of the processes involved in implementation of open access policy, specifically in relation to the impact of embargoes and the use of licences in particular disciplines; communication of the policy; the use and distribution of RCUK's block grant for open access; as well as the broader impact of the policy on different disciplines.

In 2014-15, an evaluation was carried out (by Manchester Institute of Innovation Research and Warwick Business School) into the performance of the Small Business Research Initiative (SBRI) run by Innovate UK. The final report is still to be published.

The responses to a consultation exercise undertaken by Sir Paul Nurse into the UK Research Councils[22] are currently under consideration. The review aimed to evolve the support for research provided by the Research Councils in the most effective ways. The review focused mainly on the seven Research Councils, arguing for an overarching body, Research UK (RUK), to ensure integration of the Research Councils, closer links to Innovate UK, research in other government departments and external bodies, and a sharing of resource, but not a full integration of the Research Councils as some had predicted. Amongst other issues, the review stressed the strengths of the UK system – the importance of dual support, the expertise of the Research Councils, and the fundamental role of peer review in identifying excellence.

---

[20] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/440927/bis_15_352_The_dowling_review_of_business-university_rearch_collaborations_2.pdf

[21] See: http://www.raeng.org.uk/news/news-releases/2015/july/break-down-barriers-to-university-business-collabo#sthash.EmL8qPo7.dpuf

[22] https://www.gov.uk/government/publications/nurse-review-of-research-councils-recommendations

In the Devolved Administrations, Scotland launched a new framework for Entrepreneurship and Innovation in November 2013: "Scotland Can Do" sets out the priorities to become a world-leader in entrepreneurship and innovation, including a commitment of £3m (€3.75m) for projects to accelerate economic growth. An Action Framework[23], which this sets out priorities and budget allocations, was issued in April 2014. Most recently, in March 2015, the Scottish government published Scotland's Economic Strategy[24] which sets out "how the Scottish government intends to achieve a more productive, cohesive and fairer Scotland". Based on the key pillars of increasing competitiveness and tackling inequality, the Strategy sets out four priority areas: investing in people and infrastructure in a sustainable way; fostering a culture of innovation and research and development; promoting inclusive growth and creating opportunity through a fair and inclusive jobs market and regional cohesion; and, promoting Scotland on the international stage to boost trade and investment, influence and networks.

In July 2013 the Welsh Assembly launched Innovation Wales, a strategy produced according to the principles of 'Smart Specialisation'. This underwent international peer review by members of the Smart Specialisation Platform at a meeting in Brno in July 2013.

Finally, the Northern Ireland Executive produces Annual Monitoring Reports on progress made with regard to the NI Economic Strategy. The 2nd Annual Monitoring Report was published in October 2014.

2.3 European Semester 2014 and 2015

The Council's specific recommendations to the UK were around macro-economic policy areas and issues relating to housing supply and non-R&I related labour market concerns. The Council's opinion, regarding evidence presented in the 2014 and 2105 NRPs was that the UK is expected to comply with the provisions of the Stability and Growth Pact. One recommendation was of relevance to R&I policies concerning the need to "continue efforts to improve the availability of bank and non-bank financing to SMEs. Ensure the effective functioning of the Business Bank and support an increased presence of challenger banks" (European Commission, 2015).

For reference, the specific recommendations from the Council were for the UK government to:

1. Ensure effective action under the excessive deficit procedure and endeavour to correct the excessive deficit in a durable manner by 2016-17, in particular by prioritising capital expenditure.
2. Take further steps to boost supply in the housing sector, including by implementing the reforms of the national planning policy framework.
3. Address skills mismatches by increasing employers' engagement in the delivery of apprenticeships. Take action to further reduce the number of young people with low basic skills. Further improve the availability of affordable, high-quality, full-time childcare. [25]

The 2015 UK National Reform Programme report notes the improvements to the UK's economic performance: "GDP grew by 2.6% in 2014, the strongest annual growth since 2007, and the fastest in the G7. At the end of 2014 employment was at its highest ever level at 30.9 million, more than 1 million above its pre-crisis peak. The employment rate for 3 months to December 2014 was 73.2%, the joint highest level since records began. Earnings growth has been strengthening, with total pay up 2.1% in the 3 months to December 2014 compared to a year earlier" (HM Government 2015).

[23] http://www.gov.scot/Resource/0044/00449131.pdf
[24] See: http://www.gov.scot/Topics/Economy/EconomicStrategy
[25] http://ec.europa.eu/europe2020/pdf/csr2015/csr2015_uk_en.pdf

With regard to the Council's recommendations, the UK NRP 2015 notes that with regard to reducing the deficit, substantial progress has been achieved: throughout 2014-15 borrowing is forecast to have halved as a percentage of GDP from its 2009-10 peak and in 2015 the government will have achieved 88% of the total consolidation planned to be in place by the end of 2015-16. The government is on course to deliver £121bn (c. €151bn) of fiscal consolidation by the end of 2015-16. Concerning employability, the report highlights the package of additional help, launched in 2012, to ensure that every unemployed 18-24 year old receives the necessary support. This includes initiatives such as Youth Contract, the Intensive Activity Programme and the Youth Engagement Fund. Skills issues are being addressed through initiatives such as the establishment of National Colleges to provide specialist higher level vocational training in sectors critical to economic growth, where there is a recognised skills gap (Digital Skills; Creative and Cultural Industries; Wind Energy; Advancing Manufacturing; High Speed Rail; Nuclear; Onshore Oil and Gas). A further example is the government's support for the growth of skills in new technologies and economic growth sectors through the Employer Ownership Fund (EOF). A number of apprenticeship schemes are also in operation (higher level apprenticeships, Apprenticeship Grant for Employers, Apprenticeship Vouchers). (HM Government 2015)

In addition, the UK Government is continuing to take action on access to finance across a number of policy areas including to improve the availability of bank and non-bank financing to SMEs and support the increased presence of challenger banks.

2.4 National and Regional R&I Strategies on Smart Specialisation

The concept and the fundamentally 'local – global' character of Smart Specialisation have both been acknowledged and accepted by a range of national agencies in the UK. However, it is recognised that an effective system of coordination is required both from the top-down and from bottom up. This involves government working with local partners, such as the Local Enterprise Partnerships (LEPs) (in England) to develop mechanisms for aligning national/local leadership team(s) and decision-making, to ensure that national funding initiatives complement and are complemented by any devolved activities at the local level and that national and regional strengths and challenges are addressed equally.

Many existing UK innovation support activities already fit broadly within the concept of Smart Specialisation and the Government is seeking to identify and fill any gaps or disconnections. In order to provide a framework for these and related activities, the UK Government has published a "Smart Specialisation in England" (BIS, 2014d– updated in June 2015). Although this document relates only to England, similar documents have been prepared in, Wales and Northern Ireland[26]. However, the UK Government's view is that, at the UK level, the real value of Smart Specialisation is as an ongoing process of learning, continually driving more productive and sustainable investments in innovation at all levels (Cunningham, 2015). In keeping with this view, the Scottish approach has been not to draft a separate strategy document but to draw together the elements of the national strategic framework that are linked to Smart Specialisation and to engage in furthering a Smart Specialisation Strategy as an integral part of the Scottish domestic agenda[27].

[26] For example, the Northern Ireland Framework for Smart Specialisation 2014. Available at: https://www.economy-ni.gov.uk/sites/default/files/publications/deti/framework-for-smart-specialisation.pdf

[27] http://blogs.scotland.gov.uk/smart-specialisation/about/

The Welsh Government has adopted the smart specialisation methodology to develop it's latest strategy document, Innovation Wales, which, like Science for Wales, will recognise national strengths and define Wales' future research and innovation priorities[28].

In this context, the role of the UK's Science and Innovation base acts as a sound basis for the development of smart specilsation,with strong political, institutional and financial backing. These will also be significant partners in terms of matched funding in relation to the ESIF Funds. Also, in the national context, the UK Industrial Strategy and the Sector Strategies acknowledge the importance of the spatial dimension in influencing growth and innovation policy and the means of its delivery. It should be noted, however, that the notion of smart specialisation (although not under that particular badge) is not a new concept in UK STI policy formulation. Hence, many existing initiatives already fit clearly with the overall national level priorities for STI and with the EU's RIS3 requirements.

The purpose of "Smart Specialisation for England" is five-fold:

- To identify the policies and range of public support available at national and local levels to help businesses invest in innovation, and why and how specific priorities for investment have been made;
- To help LEPs and their partners to identify opportunities to benefit from, and to contribute to, national policies and funding programmes supporting innovation; and to help them identify opportunities to collaborate with other places across England and beyond with similar investment priorities for innovation;
- To inform businesses, universities and others involved in wider research and innovation programmes e.g. Horizon 2020, about the priorities identified by LEPs for the use of European Structural & Investment Funds (ESIF) for England for the period 2014-2020 so that potential opportunities to align activity can be identified;
- To support the work of the National Growth Programme Board to oversee the management of the ESIF; and
- To fulfil the requirements of Annex X1 of Regulation (EU) 1303/2013 (BIS, 2014d).

The document makes it clear that different aspects of Smart Specialisation need to be delivered at both national and local levels, for example, measures to increase levels of private sector investment are operated primarily at the national level through the taxation system but LEPs have an important role to play in stimulating involvement and participation from local firms. Collaborative leadership for innovation is also needed at both levels. Other elements of Smart Specialisation can only best be delivered at the local level. These include:

- strengthening of local innovation 'ecosystem(s)' and building local capabilities;
- supporting local supply chains to invest and collaborate;
- catalysing and leveraging the differing opportunities of social innovation; and
- branding and positioning places as credible centres of smart specialisation.(BIS, 2014d)

LEPs and their partners are strongly encouraged to be part of this strategic policy framework, since this will facilitate access to support from the ESIF funds (currently over €6.2bn for England for the period 2014-20) for activities that aim to add value to, and also benefit from, nationally funded activities whenever these are delivered at the local level. Other relevant actors at the regional/local level are universities, councils, and various sub-national networks, clusters and alliances – often focusing on particular sectors, functions or client/member groupings. Hence, the recognised need for

[28] http://gov.wales/docs/det/publications/140313innovationstrategyen.pdf

coordination and capacity at national and local levels and between these levels. Part of the Government's assessment process for local funding will seek to assess the extent to which LEPS have sought to establish strong collaborative leadership. In particular, LEPs have been asked by Government to prepare Strategic Economic Plans which include proposals to support innovation.

According to the Government's "Productivity Plan" (HM Treasury, 2015) the government plans "to invite universities, cities, Local Enterprise Partnerships (LEPs) and business to work with the government to map the strengths of different regions through a series of science and innovation audits (SIAs). These will provide a new, powerful way to build on different regions' strengths and to maximise the economic impact from the UK's research base". The intention is for the SIAs to also support the delivery of England's Smart Specialisation strategy and the equivalent strategies within the Devolved Administrations. "The data and analysis generated by the SIA (in essence deep dives in particular geographical areas) will also boost the work of the new Smart Specialisation Hub, which has been tasked with building the evidence base and developing a community of best practice around smart specialisation in England"[29]. However, science and innovation funding in the UK will continue to be allocated on a national basis to the strongest proposals on the basis of excellence. Thus, the SIAs are not intended to form a route for the separate consideration of proposals, but instead, a way to help build evidence of potential global competitive advantage and begin to identify routes to realise that potential.

The complexity of the 'policy mix' encompassed by the Smart Specialisation concept makes it difficult to define an overall evaluation framework by which the implementation of Smart Specialisation activities may be assessed. Nevertheless, the current processes of review and evaluation can be utilised to provide evidence on how aspects of Smart Specialisation are progressing. In addition, the Government has set up an Advisory Hub for Smart Specialisation which will gather evidence and help to improve the use of it; share and disseminate best practice, improve connections between different partners, advise on compliance with ESIF procedures and, through this, support LEPs in delivering stronger collaborative proposals (BIS, 2014d).

2.5 Main policy changes in the last five years

Main Changes in 2011
New catapults begin to operate RDA closure proceeds, establishment of Local Economic Partnerships
Main changes in 2012
Formal closure of RDAs, continued development of LEPS TSB gains further responsibilities for innovation support
Main changes in 2013
No major changes BIS review: International Comparative Performance of the UK Research Base
Main Changes in 2014
Referendum on Scottish independence results in a 'no' vote – no immediate implications for UK STI system New national innovation plan released – 'Our plan for growth: science and innovation' together with evidence paper BIS review into international benchmarking of the UK science and innovation system Hauser Review of the Catapult network

[29] See: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/475097/BIS-15-537-science-and-innovation-audits-call-and-guidance.pdf

Main Changes in 2015

General Election results in formation of a majority Conservative government
Comprehensive Spending Review undertaken
HM Treasury 'Productivity Plan': Fixing the foundations: Creating a more prosperous nation
Dowling Review of Business-University Research Collaborations
Sir Paul Nurse's Review of the UK Research Councils

3. Public and private funding of R&I and expenditure

3.1 Introduction

Table 2: Basic indicators for R&D investments

Indicator	2011	2012	2013	2014	EU average (2014)
GERD (as % of GDP)	1.69	1.63	1.69	1.72	2.03
GERD (Euro per capita)	500.6	524.5	532	595.9	558.4
GBAORD (€m)	10,496.14	11,226.292	11,757.565	12,603.275	92,828.145 (Total EU-28)
R&D funded by BES (% of GDP)	0.78	0.74	0.78	0.8	1.12 (2013)
R&D funded by PNP (% of GDP)	0.08	0.08	0.08	0.08	0.03 (2013)
R&D funded by HES (% of GDP)	0.02	0.02	0.02	0.02	0.02 (2013)
R&D funded from abroad	0.3	0.32	0.31	0.33	0.2 (2013)
R&D performed by HES (% of GDP)	0.44	0.44	0.45	0.45	0.47
R&D performed by government sector (% of GDP)	0.15	0.13	0.13	0.13	0.25
R&D performed by business sector (% of GDP)	1.08	1.03	1.08	1.11	1.3

Source: Eurostat

3.2 Smart fiscal consolidation

3.2.1 Economic growth, fiscal context[30] and public R&D

The UK lost around 4.6% of its real GDP during 2008-09. However, relatively low growth of ca. 1.4% p.a. followed over the next three years. On the back of loose monetary policy, supportive government policy and employment growth, domestic demand started to strengthen in 2013 and led to an annual GDP growth of 2.9% in 2014. As the output gap closes the Commission expects growth to become more moderate at 2.3% in 2015 and to settle at 2.1% in 2016-17.

Public finances were strongly impacted by the 2008-09 crisis. The already high budget deficit (2008: 5.1%) jumped to almost 11% of GDP while overall GDP declined. Since 2010 the government has been implementing fiscal consolidation focusing mainly on expenditure cuts accounting for approximately 80% of the consolidation measures. As a result the headline deficit fell to 5.0% in 2014-15. Gross government debt continues to increase and is expected to peak at 87.6% of GDP in 2015-16 and to fall slightly to 86.1% during 2017-18. During 2017-18 the Commission expects the deficit to fall to 1.7% of GDP.

[30] Sources: DG ECFIN, http://ec.europa.eu/europe2020/pdf/csr2016/cr2016_uk_en.pdf

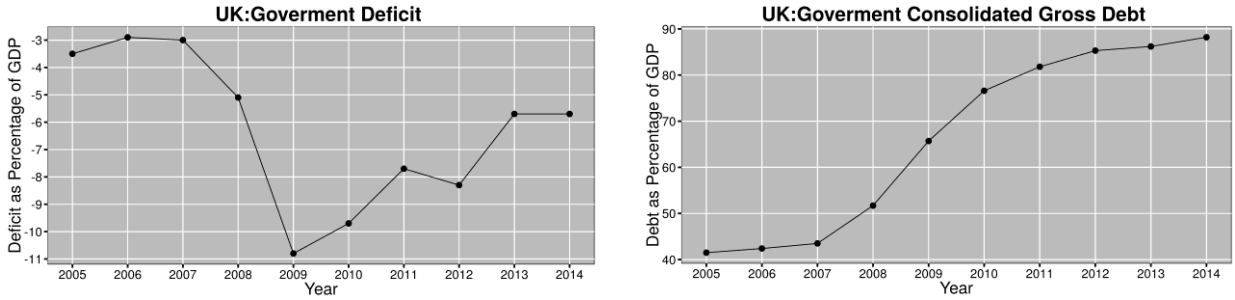


Figure 4: Government deficit and public debt

Data source: Eurostat

Total GERD in the UK was €33,999m in 2013. There are four main sources of R&D funding: the business sector (€15,710m), the government (€9,902 m), the private non-profit sector (€1,604m), and foreign funding (€6,350m). Direct funding from the government goes to business enterprises (€1,941m), the research performed within government (€2,104m) and the higher education sector (€5,650m).

Table 3: Key UK Public R&D Indicators

	2007	2009	2013
GBAORD, % of gov. exp.	1.47	1.28	1.28
GERD, % of GDP	1.69	1.75	1.69
out of which GERD to public, % of GDP	0.59	0.65	0.58
Funding from GOV to, % of GDP			
Business	0.07	0.08	0.1
Public (GOV+HES)	0.43	0.46	0.38
Total	0.52	0.57	0.49
EU funding, % of GDP	n.a.	0.03	0.04.

Source: Eurostat

3.2.2 Funding of R&D activities

Figure 5 below shows the historical evolution of GERD financing in current prices in the UK.

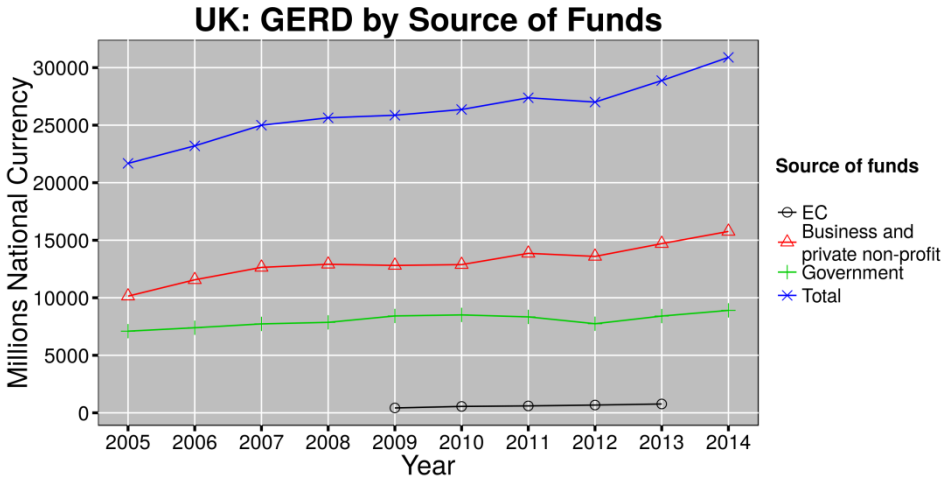


Figure 5: Funding of the total GERD

Source: Eurostat

With the exception of 2012, total GERD, in nominal terms, grew in the period 2005-2014, and particularly in the periods 2005-2007 and 2012-2014. This was due to the increase of the contribution from the business sector which is the main funder of UK R&D. Figure 5 also shows that the government funded GERD in 2014 fully had recovered from a mild decline in 2011-2012. The data about the contribution from the European Commission is sparse, but it increases monotonically between 2009 and 2012.

3.2.2.1 Direct public funding from the government

Figure 6 shows a sharp increase of the total (civil) appropriations from 2012 onwards and a slight reduction in the gap between civil and total appropriations, with military R&D appropriations remaining a substantial component of the total. An increase in certain investments has been announced by the Government, but the cuts in R&D budgets of a range of ministries could explain the trends in this chart. However, in terms of percentage of GDP both the appropriations and government GERD follow a negative trend from 2009 (peak due to the low GDP) and are well below pre-crisis levels in 2014

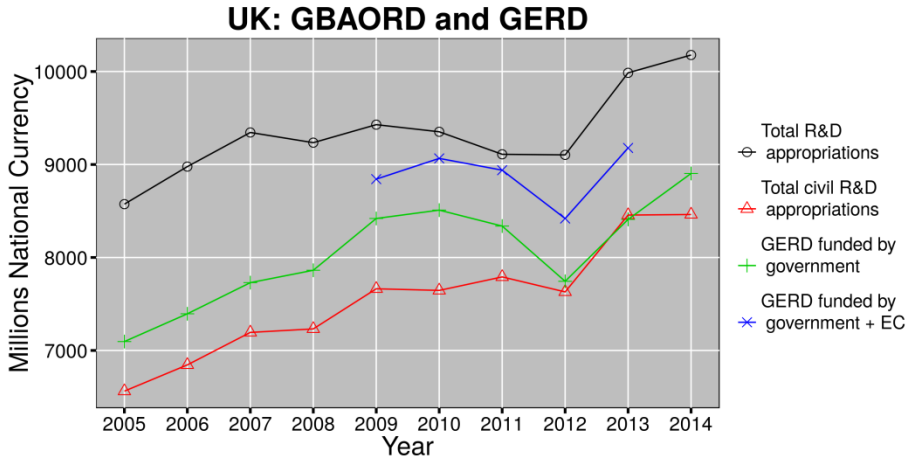


Figure 6: R&D appropriations and government funded GERD in millions of national currency

Source: Eurostat

The government states in its Science Budget (BIS, 2014d) that despite the need for tight control over public spending, it "remains committed to supporting our world-class science and research base". The ring-fencing of the Science Budget (in cash terms) announced in 2010 continues to protect spending (although it is subject to erosion by inflation, which has been very low over the recent period – see below). In addition, the government has announced investment in science infrastructure of £1.1b (c €1.5b) per year, protected in real terms to 2021, together with funding for new programmes such as Quantum Technologies, the Newton Fund, and further investment in high level skills. Thus, overall BIS investment in science and research will be £5.8b (c €7.7b) in cash terms for FY2015/16, representing an increase in the overall allocation compared to recent years.

Nevertheless, the Science Budget [31] Allocation also notes that this commitment represents a challenge to ensure that maximum benefit is obtained from this investment, which will imply continued efficiency savings, increased collaboration to develop creative solutions to shared goals, and greater efforts to leverage business and charity funding. As an example of this process, BIS has reduced teaching grant spending (via the Higher Education Funding Councils) by £1,033m (c €1,378m) from a 2013-14 outturn of £3,048m (c €4,064m) - a reduction of 34% - replacing it with student-routed income-contingent repayment loans. According to BIS (2015a) this "has been achieved whilst

31 That is, the Government's funding allocation to the Research Councils, Higher Education Funding Council for England, the Royal Society, the British Academy, the Royal Society for Engineering and a number of cross-cutting programmes (Science and society, Foresight, International activities and Evidence and evaluation).,

maintaining delivery of the Coalition Government's strategy in protecting funding for high-cost subjects – especially Science, Technology, Engineering and Mathematics (STEM), widening participation and safeguarding small and specialist institutions". Despite the recent Nurse review into the future of the Research Councils (see Section 2.2.1), it has been reported that the government has asked BIS to find £450m (c €600m) to cut in FY2015/16. Consultants from McKinsey and Company have been hired by BIS to help it make the 50 or so bodies under its authority "simpler, cheaper and better" (Smith, 2015).

Table 4: Allocation of the Science Budget; resource and capital funding 2010-2016

	£M	10-11 baseline	2011-12	2012-13	2013-14	2014-15	2015-16	total
Capital	SR Allocation	873	514	449	416	517	1,110	3,879
	Additional funding	-	246	163	514	551	39	1,513
	Total	873	760	612	930	1,068	1,149	5392
Resource	SR Allocation	4,576	4,576	4,576	4,576	4,576	4,576	27,456
	Additional funding	-	-	-	-	127	134	261
	Total	4,576	4,576	4,576	4,576	4,703	4,710	27,717
Total	SR Allocation	5,449	5,091	5,025	4,991	5,093	5,686	31,335
	Additional funding	-	245	163	514	678	171	1,773
	Total	5,449	5,336	5,188	5,506	5,771	5,857	33,109

Source*:* BIS (2014d)

3.2.2.2 Direct public funding from abroad

The data on public funding from abroad is rather sparse for the UK. In fact, the business sector is the major funder of UK GERD from abroad (around 70% of the total external R&D funding). The EC is the main external public funder and it has been monotonically increasing its share of the GERD from 2009 onwards. Overall, funding from abroad is an important contribution to the GERD whereof it represents a fluctuating share of between 16%-20%. The abroad contributions from government and international organizations play a minor role.

Table 5: Public Funding from Abroad to R&D in the UK (in millions of national currency)

Source from abroad	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total	4178.3	3954	4319.24	4550.24	4303.50	4646.20	4863.70	5358.30	5392.80	5836.10
BES					3447.60	3649.41	3380.80	3817.60	3881.90	
EC					423.10	556.30	601.10	675.20	768.20	
GOV							113.60	101.90	51.20	
HES							1.40	1.40	2.90	
Internatio-nal Organiza-tions					81.70	79.13	142.40	150.60	140.20	
Total as % GERD	19.27	17.04	17.28	17.75	16.64	17.62	17.76	19.84	18.68	18.89
EC as % GOVERD					5.03	6.54	7.21	8.72	9.13	

Source: Eurostat

Distribution of public funding

Figure 7, below shows how the distribution of public funding to performing sectors has evolved over time:

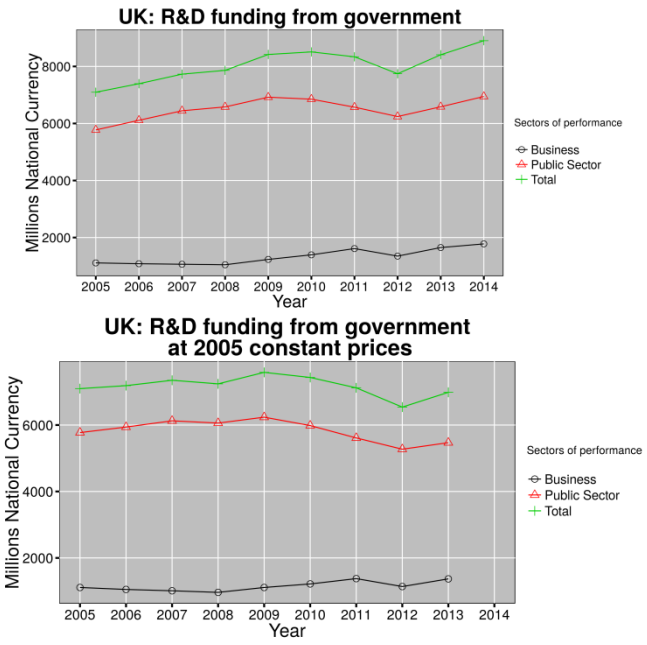


Figure 7: Government intramural expenditure by sectors of performance

Data source: Eurostat

Not surprisingly, the public sector (GOV + HES) is the main recipient of government funded GERD (Figure 7, left). After the drop between 2010 and 2012, total funding from the government increased and in 2014 surpassed the 2009 levels. Funding received by the public sector, although it followed similar trend, has not increased proportionally. This is due to the fact that the funding given by the government to the business sector is gradually increasing (with an exception in 2012). When fixed to 2005 constant prices,

the decline of total government funding (and its component allocated to the public sector) from 2010 to 2012 are clearly emphasized.

3.2.3 Indirect funding – tax incentives and foregone tax revenues

Considering the absence of harmonisation of tax regimes in EU law, data come directly from national sources, using domestic definitions (attention should be paid when interpreting data from different sources). The amount spent on R&D tax incentives is slightly less than direct government support in the form of R&D grants and subsidies.[32] 'The use of schemes increased, notably during the crisis. Since schemes were launched in 2000-2001 up until 2013, over 100,000 claims have been made and more than £9.5 b in tax relief claimed according to the table of tax credit claims 2000-2013 below.[33] There was a significant rise in claims from large companies in 2008, remaining high throughout the crisis period. There is both an increase in the number of claims made by companies, as well as the size of individual claims by large companies.

An SME scheme was launched in 2000 and was extended in 2002 to include larger companies beyond the SME definition, introducing a separate scheme, the Large Companies Tax Credit. Another scheme introduced in 2003 based on the SME tax credit scheme is the vaccines research relief. The Above the Line scheme was introduced in 2013. There are also R&D capital allowances (since 1997) and since 2013, a patent box scheme.

The existing schemes can be described as follows:

Small or Medium Sized Enterprise (SME) Scheme: the R&D relief offers a deduction from corporation tax liability for R&D expenditure. The deduction rate has increased in the past five years. Currently, it offers SMEs a 125% deduction (e.g. for every £ 100 spent on R&D, a firm can deduct another £125 from its pre-tax corporate income). Furthermore, in case a firm did not make any profits, it can receive a tax refund of 24.75% from the amount of expenditure on R&D. The scheme includes an indefinite carry forward facility and the maximum amount of total amount of government support that one R&D project can receive is £7.5m.

Large Company Scheme: Currently two schemes coexist for large companies investing in R&D: the optional *Above the line (ATL)* scheme and *R&D relief for large companies*. The design of the latter one that will cease in April 2016, is essentially the same as for the SMEs, offering a lower rate of 30%. The ATL, that will become mandatory for all large companies after April 2016, offers a 10 percent taxable credit on the amount of firm's R&D activity set against corporation tax liabilities. For firms without corporation tax liabilities, the credit is fully paid out net of tax with a cap equal to the total sum of *Pay-as-you-earn (PAYE)/National Insurance Contributions* (NIC) liabilities. No minimum amount of investment in R&D is required and firms can carry forward losses indefinitely.[34]

[32] OECD, 2013, http://www.oecd.org/sti/2013OECD-NESTI%20RDTaxIncentiveSummaryDescription_03Apr2014.pdf
[33] R&D Tax Credits Statistics, August 2014: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/356382/Research_and_Development_Tax_Credits_-_August_2014.pdf
[34] Report to DG Taxud: 'A Study on R&D Tax Incentives Annex: Country fiches' *DRAFT FINAL REPORT*

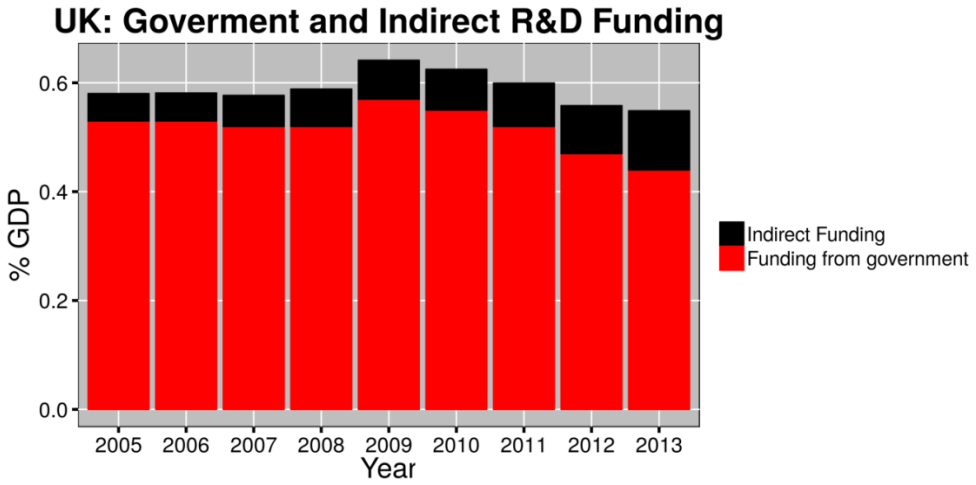


Figure 8: indirect funding to R&D in the UK (from R&D Tax Credits Statistics, August 2014)

As seen above, the indirect support to R&D in the UK is far from marginal and has increased its importance in recent years.

3.2.4 Fiscal consolidation and R&D

Figure 9 below shows the scatterplot of the structural balance versus the GBAORD as % GDP (left) and versus the GERD as % GDP (right)[35]:

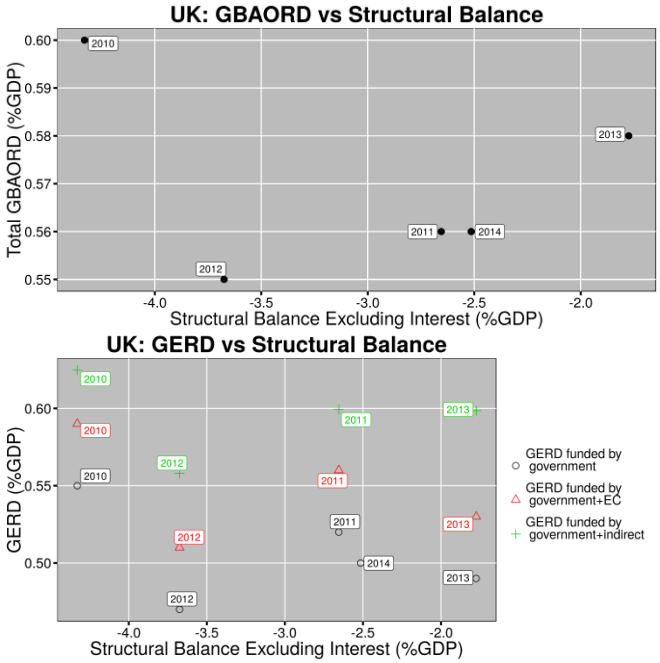


Figure 9: Fiscal consolidation and R&D

[35] Structural balance data comes from the AMECO database the other indicators were taken from Eurostat, and the British Government

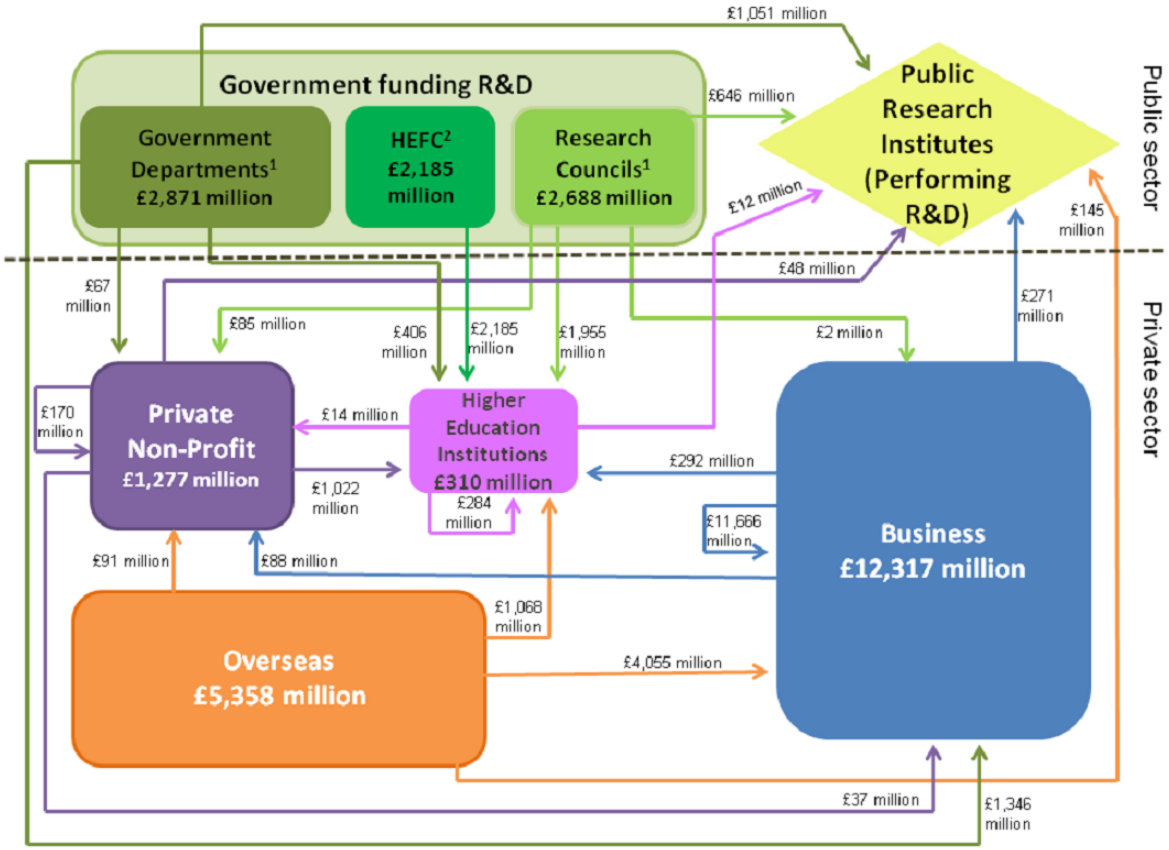
The fiscal consolidation process started in 2010 yielded mixed results and it is far from being complete. It is clear that the structural balance has improved significantly between 2010 and 2013/14, although still negative. Meanwhile both GBAORD and government financed GERD decline in the post-crisis period (about 0.05% and 0.08% of GDP respectively between 2010-2012). The 2013 pick-up of the GBAORD apart from being . very small (ca. 0.02% of GDP) it was followed by another slight decrease in 2014. Therefore, it is evident that post-crisis fiscal consolidation (austerity measures) has come at the expense of direct public financing of R&D, which has been cut across the board, including on R&D. Indirect financing is rather important in the UK, and although adding them to the direct public support does not alter the final conclusion they improve the picture by reducing the differences between the years (i.e. the difference in the total public support between 2010 and 2013 is much smaller than that of direct funding only)

3.3 Funding flows

3.3.1 Research funders

The Department for Business, Innovation and Skills (BIS) is the major provider of research funds for the public sector. It is also responsible for the allocation of the UK Science Budget via the Research Councils and, to a lesser degree, the Royal Society and Royal Academy of Engineering. The Research Councils, which in turn support R&D and research training both in HEIs and their own institutions, provide research grants for both programmes, projects and research centres. In addition, some of the Councils maintain their own research facilities in the UK and abroad for university researchers. Substantial funds are also allocated in the form of block grants to UK universities from the Higher Education Funding Councils and their equivalents in the devolved administrations (see below). These block grants are made on the basis of an allocation exercise (the Research Excellence Framework - REF) based on a peer review process which assesses the research outputs and research impacts of university 'research-active' staff. A comprehensive overview of the flows of UK government funding for R&D is provided in Figure 2.

Figure 10: Flows of R&D funding in the UK, 2012: Source: ONS, 2014[36, 37] .



The overall size of the Science Budget is confirmed through the Chancellor of the Exchequer's Spending Review announcement. Following this, the Research Councils, HEFCE, the UK Space Agency and the National Academies are required to set out delivery plans for the CSR period, taking account of BIS priorities for science and research funding. Ministers' decisions on the allocations of science and research funding took account of the extent to which the Delivery Plans met the BIS priorities and also took account of views expressed in a wide-ranging consultation process on science spending.

The UK Government also provides support to the private sector to help companies invest in R&D through a number of mechanisms, including tax credits administered via the Treasury, and Innovate UK (formerly the TSB), which also has responsibility for the formulation and delivery of a national technology strategy. Largely through its Technology Programme, Innovate UK will deliver over €500m of funding in 2014-15 to support technology and innovation, through collaborative work between businesses or between businesses and academia[38]. Other Ministries and Departments, particularly the Department for Environment, Food and Rural Affairs, the Ministry of Defence and the Department of Health, also have significant research portfolios within their areas of responsibility, and commission R&D through their own laboratories and institutes (or, in

[36] http://www.ons.gov.uk/ons/rel/rdit1/gross-domestic-expenditure-on-research-and-development/2012/stb-gerd-2012.html#tab-R-D-Expenditure-by-Funding-Sector

[37] Average exchange rate for 2012: £1.00 = €1.2312

[38] Innovate UK Delivery Plan 2014-15. Available at: https://www.gov.uk/government/publications/innovate-uk-delivery-plan-2014-to-2015

many cases, their former institutes which are now privatised or have intermediate agency status) or from outside sources, especially HEIs.

As can be seen from Figure 9, the private-non-profit sector forms a major source of funds for the public sector research base. Comprising a range of charities and foundations, the largest funders are the medical research charities, such as Arthritis Research UK, Breast Cancer Campaign, the British Heart Foundation, Cancer Research UK and the Wellcome Trust In 2012, the sector provided some £1,277m (c €1,600m) of research funds, some of it to Public Sector Research Establishments and private research facilities, some to its own research facilities, but the largest share (£1,022m/c €1,278m) went to support research in the HE sector.

3.3.2 Funding sources and funding flows

It is not possible to distinguish regional or local budget allocations for research since these are provided through a range of mechanisms to individual researchers, research centres and institutes, PSREs and HEIs: research funds are not allocated on any regional basis. EU Framework funding is applied for and allocated competitively on a similar basis with no overall assessment of the regional destination of such funds.

Although EU Structural Funding is allocated on a regional basis (see below), these figures cover a seven year period and no distinction is made between the uses of such funds. However, the accompanying evidence paper for Our Plan for Growth notes that, in England, about £600m (c. €750m) of these funds will be allocated to research and innovation activities in the 39 LEP areas (BIS, 2014b). Some £10.8b (c €13.4b) will be allocated over the funding period – an average of £1,543m (c €1,920m) per annum: this compares to a figure for total UK GERD of £28.875b (c €36.093b) in 2013. The ERDF, which is more closely concerned with research and innovation, contributes around €3.6b of the total Structural Fund contribution.

Table 6: EU Structural funds by region

	2014-20	
Region	£m	€m (approx.)
England	6,937.2	8,671.2
Scotland	894.6	1,118.3
Wales	2,412.5	3,015.6
Northern Ireland	513.4	641.8

Source: BIS, 2014e

Between 2007 and 2014, the EU contribution for 7th Framework Programme funding to the UK amounted to €6,880.53m, while in 2013 and 2014, the UK overtook Germany as the number one recipient of funding from FP7 (BIS, 2014b). More detailed figures for FP6, FP7 and Horizon 2020 participation are provided below.

Table 7: FP7 UK and EU28 data

	No. projects	No. participants	No. coordinators	EU Contribution	% of total EU
FP6 - UK	4,549	9,120	1,719	2,526,632,188	16.0%
FP6 – EU28	36,796	67,696	9,328	15,749,796,104	100.0%
FP7 - UK	10,553	18,047	5,265	7,052,806,132	17.2%
FP7 – EU28	72,440	120,697	23,204	40,917,932,471	100.0%
H2020 – UK	1,924	3,027	1,055		15.5%
H2020 – EU28	13,219	21,851	4,970		100.0%

Source: DG R&I

In all categories, the UK is second only to Germany except for the number of coordinators in FP6 in which instance it provided the highest number of all EU Member States.

More broadly, as noted above, the UK receives significant research funding from abroad: the contribution from this source rose from £5,172m (c €6,465m) in 2011, through £5,327m (c €6,659m) in 2012 to £5,393m (c €6,741m in 2013 (ONS, 2015[39]).

The private sector is also both a major funder and performer of R&D. In 2012 the sector´s total expenditure on R&D was €21.96b. The majority of this (€14.39b) came from the business sector itself, with €1.66bn from Government sources (mainly on defence) and €4.19b from overseas sources. By comparison, UK GOVERD for 2012 was €9.63b.

3.4 Public funding for public R&I

3.4.1 Project vs. institutional allocation of public funding

The largest performer of research in the UK is the Higher Education Sector. This receives funding via a mix of institutional block grants, competitive 'responsive mode' grants and through the Higher Education Innovation Fund which encourages knowledge transfer activities. The second largest public research budget is that disbursed via the Research Councils. The private sector also receives substantial R&D support, via a range of innovation support measures, rather than direct state aid for research: the largest single instrument being the combined R&D Tax Credit schemes, which account for some 75% of the public support for private R&D.

UK funding of research takes a variety of forms and routes. The largest single budget is probably that allocated to defence R&D although a substantial proportion will be dedicated to development and demonstration purposes rather than research. Much of this budget will go to the private sector, not only in the UK. Other thematic areas, notably health and environmental funding will also attract significant budgets, via the responsible ministries, and again to a variety of research performers, although the Public Sector Research Establishments recive the majority.

The share of responding funders' total budget allocated as project-based funding was 80% in 2013 (higher than the EU average), compared to 20% of the total budget allocated as institutional funding based on institutional assessment and/or evaluation (below the EU average). No trend data are available on these figures (European Commission, 2014a). A further proxy indicator may be derived from GBAORD expenditures:

[39] Available at: http://www.ons.gov.uk/ons/rel/rdit1/gross-domestic-expenditure-on-research-and-development/2012/stb-gerd-2012.html#tab-R-D-Expenditure-by-Funding-Sector

Table 8: General University Funds

	2011	2012	2013
General advancement of knowledge financed from General University Funds	€2,822 m	€2,731 m	€2,834 m
General advancement of knowledge financed from other than General University Funds	€2,091 m	€2,025 m	€1,593 m

However, these figures do not align closely with the data derived from the Higher Education funding councils and the research Councils provided below.

3.4.2 Institutional funding

Institutional funding in the UK is almost always allocated based on institutional assessment. The main stream of support is that allocated to the universities in the HE Sector, in the form of a block grant from the Higher Education Funding Council for England (HEFCE) and its equivalent bodies in the devolved administrations. This is allocated on the basis of a mechanism known as the Research Excellence Framework (formerly the Research Assessment Exercise – RAE), a peer review process which produces 'quality profiles' for each submission of research activity made by HEIs. There were four RAEs (in 1992, 1996, 2001 and 2008). Once funding levels for institutions (which are actually made on a subject oriented 'cost-centre' basis and which may apply at a sub-departmental level) have been set, these are used for the annual allocation of funding until the next round of assessment One of the major criticisms of the process is the enormous amount of staff time and resources that HEIs have to devote to the process of preparing submissions. After a series of extensive consultations and reviews, the Higher Education Funding Councils replaced the RAE with the new REF, which is more "metrics-based" and which also takes the notion of research 'impact' into account. The first REF took place in 20013/14.

University block funding supports research infrastructure costs. Total research funding from the four UK HEFCs from 2011 to 2013 was £2.257b (c. €2.752b); £2.185b (c. €2.731b); and £2.297b (c. €2.871b) respectively. This was provided by the Scottish Funding Council (SFC) in Scotland, Higher Education Funding Council for Wales (HEFCW) in Wales and Department of Education and Learning Northern Ireland (DELNI) in Northern Ireland.

3.4.3 Project funding

The largest category of project-oriented, competitive or 'responsive mode' funding is that provided via Research Council grants and programmes. Between 2011 and 2013, the UK Research Councils provided research funding of £3.189b (c. €3.986b), £3.001b (c. €3.751b) and £3.366b (c. €4.208b).

Research Council funds are awarded on the basis of applications made by individual researchers, which are subject to independent, expert peer review. Awards are made on the basis of the research potential and are irrespective of geographical location. Responsive mode funding is very flexible and supports projects ranging from small travel grants to multi-million pound research programmes and from one-month to six years. The funding covers a wide range of activities, including research projects, feasibility studies, instrument development, equipment, travel and collaboration, and long-term funding to develop or maintain critical mass. The major beneficiaries of responsive mode funding are individual researchers or research teams at Higher Education Institutes. This type of funding may be categorised as 'bottom-up' or 'free funding'.

Each Research Council funds research and training activities in a different area of research ranging across the arts and humanities, social sciences, engineering and physical sciences and the medical and life sciences. RCUK supports over 50,000

researchers including 19,000 doctoral students, around 14,000 research staff, and 2,000 research fellows in UK universities and in their own Research Institutes[40].

3.4.4 Other allocation mechanisms

A significant amount of R&D is commissioned by the Government through the form of contracts. These may be extramurally with the higher education sector, the private sector, and Research and Technology organisations, or intra-murally with Non-Departmental Public Bodies and Public Sector Research Establishments. No detailed breakdown of these figures is available. Similarly, detailed figures on the allocations of the Research Councils to their own institutes and units and on departmental research spending at non-academic research performing organisations are not available.

3.5 Public funding for private R&I

3.5.1 Direct funding for private R&I

The majority of the remaining Government support for research funding falls within the broad area of innovation support and include various knowledge transfer support mechanisms and tax credits for R&D. These target a mix of research performers and all parts of the R&D spectrum from fundamental research to market innovation. Other than the tax credits for R&D (which provides indirect support – see below), the main competitive direct-funding support scheme for companies to carry out R&D is the Smart programme (formerly Grant for R&D) which targets SMEs and is funded through BIS. A large number of schemes are aimed at linking the public and private sectors (which may therefore be categorised as 'research networks'), thereby promoting the flow of new research ideas into new technologies and commercialised products, processes and services: examples include several of Innovate UK's schemes such as Knowledge Transfer Networks, Collaborative R&D and Knowledge Transfer Partnerships – all funded through the Technology Strategy Board, and the Research Councils' CASE awards. Many of these schemes involve variable elements of co-funding from industry and are not always eligible for the definition of 'direct funding'. Several schemes also aim at the stimulation of additional financing support, particularly for SMEs.

3.5.2 Public Procurement of Innovative solutions

In 2013/14, the UK public sector spent a total of £242 billion (€319b) on procurement of goods and services (including capital assets); this accounted for 33% of public sector spending (total managed expenditure).[41] Public procurement accounts for approximately 14.46% of GDP. [42] Procurement by central and local governments according to Government figures[43] is divided as follows: 58% Central Ministerial Departments and NHS, 33% Local Government, 7% Devolved Governments, 2% Non-Ministerial Department. The Government has set a target of procuring 25% of goods and services by value from small and medium-sized enterprises (SMEs) by 2015, which it met in 2014 when it spent 26% with SMEs.

Legal public procurement framework

The UK transposed the two 2004 Directives on public procurement (2004/17/CE and 2004/18/CE) in 2006. The following regulations came into force on 31 January 2006 to implement the 2004 directives:

[40] http://www.rcuk.ac.uk/
[41] http://researchbriefings.files.parliament.uk/documents/SN06029/SN06029.pdf
[42] 2014, European Commission, DG Internal Market study: http://ec.europa.eu/internal_market/publicprocurement/docs/modernising_rules/20141105-indicators-2012_en.pdf
[43] Public Expenditure Outturn Updates, 25 February 2010: https://www.gov.uk/government/publications/standards-and-policies-for-hm-treasury-statistics

- Public authorities (the State, regional and local authorities and other public bodies): The Public Contracts Regulations 2006 [44](SI 2006 No.5);
- Utilities (i.e. certain operators in the water, energy, transport sectors): The Utilities Contracts Regulations 2006 (SI 2006 No.6)[45].

A new set of directives were agreed in early 2014 (2014/24/EU and 2014/25/EU). They are now being transposed into UK law by the UK government (for England, Wales and Northern Ireland) and the Scottish government (for Scotland).[46]

The Defence and Security Public Contracts Regulations 2011 is the enabling UK legislation for the EU Defence and Security Directive (2009/81/EC). This came into force on 21st August 2011.

The Public Services (Social Value) Act 2012[47] requires relevant authorities that are engaging in a procurement exercise to consider how the proposed procurement might improve the economic, social and environmental well-being of the relevant area, and how these improvements might be secured.[48]

Pre Commercial Procurement and Public Procurement for Innovation landscape

Innovative public procurement (PPI) is encouraged in the UK and the Government has produced guidelines under the concept of Forward Commitment Procurement (FCP), a tool introduced in 2006. This is "an early market engagement tool that brings together progressive thinking and best practice from the private sector and the innovation and procurement communities, together with the understanding of the demand side barriers to the commercialisation of innovative goods and services. Although designed to address the particular barriers to market faced by environmental innovations, the FCP approach can, where appropriate be used to deliver efficiency savings and support the procurement of innovative solutions in other markets, such as sustainable development, healthcare and construction" (BIS, 2011). The FCP concept covers both public and private sector organisations.

In spring 2012 the Department for Business, Innovation and Skills (BIS) launched a pilot scheme labelled Procurement Compacts[49]. The idea of this scheme was for large public and private organisations to join forces to buy products and processes that help reduce the carbon footprint of private and public actors (see below under initiatives). Organisations would not only bundle their demand, but also develop joint roadmaps of future demand, sending clear signals to the industry in order to both induce the generation of new innovations and to accelerate the diffusion of new products and services.

In the UK, the Small Business Research Initiative is the main support scheme that focuses on demand–side issues, operating under the auspices of Innovate UK; it involves several government departments in supporting innovation procurement solutions from SMEs. It was first established in the UK in 2001 to increase access of small and medium-sized enterprises (SMEs) to public sector procurement, and to support the procurement of R&D with an option in the R&D contract to acquire the innovation generated. The scheme was evaluated in 2015 and the report is pending publication by Innovate UK.

The SBRI has two main roles; the first role is 'Operational Effectiveness' and involves the government acting as a 'lead' customer for new products and services. This modality represented roughly two thirds of the calls and around 50% of the SBRI spending in the

[44] http://www.legislation.gov.uk/uksi/2006/5/contents/made
[45] http://www.legislation.gov.uk/uksi/2006/6/pdfs/uksi_20060006_en.pdf
[46] http://researchbriefings.files.parliament.uk/documents/SN06029/SN06029.pdf
[47] http://www.legislation.gov.uk/ukpga/2012/3/enacted
[48] Public Procurement. Standard Note: SN/EP/6029. Last updated: 31 January 2014. http://www.parliament.uk/briefing-papers/SN06029.pdf
[49] https://www.gov.uk/government/policies/investing-in-research-development-and-innovation/supporting-pages/using-government-purchasing-power-to-stimulate-innovation

financial year 2011–2012. Departments such as the Ministry of Defence (MoD) and the Department of Health (DoH) have been the main clients for this action. Departments have tended to run the competitions and review processes themselves, with the TSB acting as facilitator. This would, in principle, ensure the necessary context-specific skills and understanding of the problem for which procuring an innovative technology delivers the solution. The second role is to support 'Strategic Objectives', i.e. to provide a route to market for innovations that support broad policy objectives, with the solution developed through SBIR providing opportunities for the market more broadly. In this mode departments, such as the Department for Environment, Food and Rural Affairs (Defra) and the Department of Environment and Climate Change (DECC), would run competitions for innovations that support their policy objectives. In this role, the SBRI would drive the process, articulate the call, conduct the assessments and support the award process. The projects under this second modality have tended to be smaller, with the exception of the 'Retrofit for the Future' initiative, which ran five projects at a cumulative value of £18m. Retrofit for the Future was run in conjunction with DCLG to identify innovative solutions to reduce carbon emissions and energy use in the existing social housing stock.[50]

The BIS governance framework specifies that each support programme above a defined funding threshold must present a business case in order to justify its support. Each business case contains information about the programme's benefits, costs, risks and timescales used to judge whether or not the programme is (and remains) desirable, viable and achievable (BIS, 2010). All business support schemes are also subject to periodic evaluation in order to assess their effectiveness and performance, to gain policy insights and lessons for their continued implementation and to assess that the rationale for their creation remains unchanged.

PCP/PPI initiatives

Within the SBRI framework, six of the larger UK government departments targeted £100m in Fiscal Year 2013/14 and £200m in FY2014/15 in SBRI initiatives.[51]

The UK Energy Technology Institute (ETI) was set up to accelerate the development, demonstration and commercial deployment of energy technologies and help achieve climate change goals. Its approach illustrates how an entity that is financed by a combination of public and private funds, and in which private and public partners collaborate on research and innovation, can undertake a PCP in compliance with state aid rules.[52]

BIS and the Prince of Wales UK Corporate Leaders Group launched three low carbon procurement compacts (2010-2015). Compacts are partnerships between government and the voluntary/non-profit sector that commit the public sector to be a customer for low carbon products and services. They are an invitation to suppliers of all sizes, particularly SMEs, to seize the opportunities available.

The compacts are in the areas of:

- Heat and power from renewable biomethane;
- Low carbon transport;
- Zero carbon catering

The initiative aims to significantly reduce UK emissions and demonstrate to other organisations that low carbon solutions can work.

[50] UK Public Procurement of Innovation: The UK Case, Elvira Uyarra, Jakob Edler, Sally Gee, Luke Georghiou and Jillian Yeow

[51] http://www.slideshare.net/investni/pat-doyle

[52] http://cordis.europa.eu/fp7/ict/pcp/case-eti-uk-pcp.pdf

As noted in Section 1.2.2 above, all business support schemes are also subject to periodic evaluation in order to assess their effectiveness and performance, to gain policy insights and lessons for their continued implementation and to assess that the rationale for their creation remains unchanged.

3.5.3 Indirect financial support for private R&I

The UK employs R&D tax credit schemes and these in fact form the largest single source of government support for business R&D. These provided almost £1.2bn (€1.5bn) of relief to in excess of 12,000 companies in the financial year ending March 2012. This supported around £11.9bn (€14.9bn) of expenditure, an estimated two-thirds of all business R&D revenue expenditure, reducing the cost of the qualifying expenditure by around 25% for SMEs and around 8% for large companies. In addition, as of 1 April 2013, companies have been able to apply for a lower rate of Corporation Tax on profits earned on patented inventions and certain other innovations. This scheme is being introduced progressively over 5 years: a further cut will be made to the main rate of corporation tax from 23% to 20% in April 2015. Most recently, in the Autumn Statement 2014, it was announced that government will increase the rate of the 'above the line' credit from 10% to 11% and will increase the rate of the SME scheme from 225% to 230%, from 1 April 2015.

As noted in Cunningham (2015), precise figures are unavailable to be able to provide a clear picture of any trends in the balance of direct versus indirect funding over time, although since there is some evidence that companies, at least in the early stages of the schemes, increased their uptake of the R&D Tax Credits, it is likely that the balance of expenditure has slightly increased in favour of indirect schemes since the introduction of the tax credits. However, as no major new measures have been introduced in recent years and no significant funding increases made to direct measures, it is likely that the overall balance has remained more or less static for the last three years.

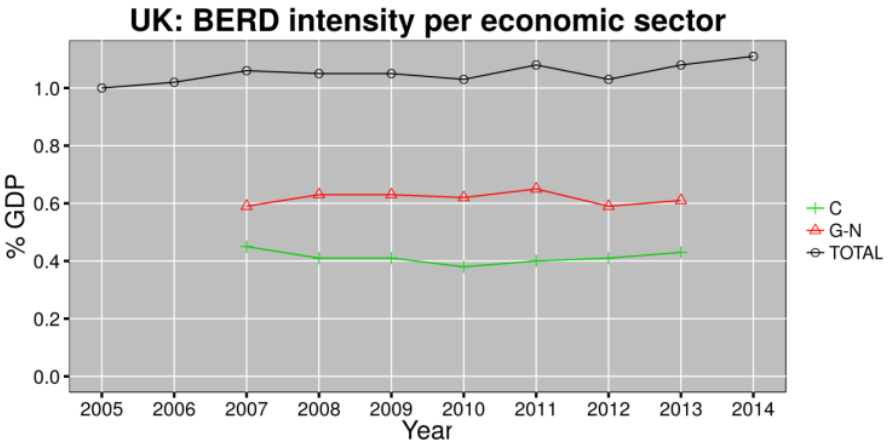
3.6 Business R&D

3.6.1 The development in business R&D intensity

As seen below, UK BERD has been rather stable, fluctuating only slightly in a 0.1% of GDP "band" in the last decade, between its 2005 level of 1% and its 2014 level of 1.11% of GDP. Manufacturing and services were its major components, together accounting for more than 95% of the BERD expenditure in the period under scrutiny and with the latter out-pacing systematically the former with around 0.2% of GDP. Both of them were slightly fluctuating, but their overall trend between 2007 and 2013 is that of stagnation. The UK economy is made up of a strong financial and businesses services sector, and while the share of manufacturing in the economy is much smaller and has seen a decline over a number of decades, R&D in the manufacturing sector includes aerospace, automotive, and chemicals, with an important EU and global export component. An important share of business R&D in the UK is conducted by foreign-owned companies in 2013[53].

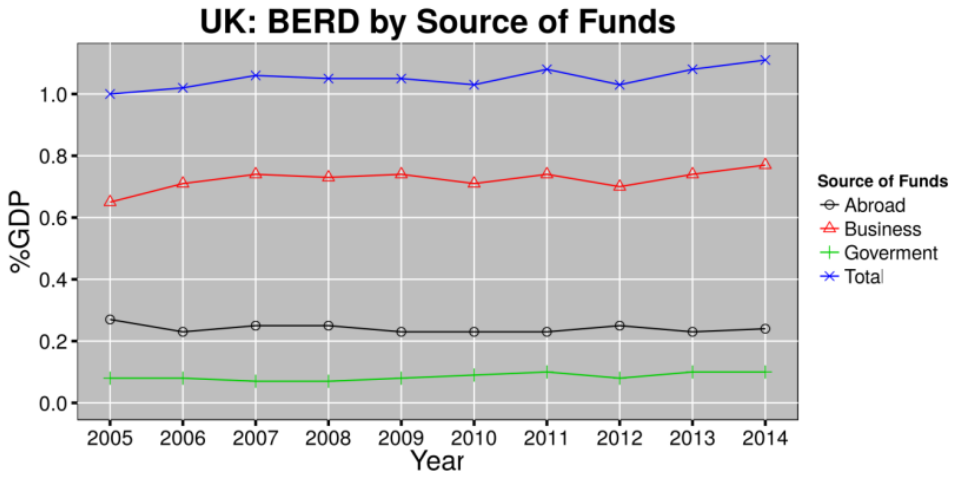
[53] ONS, 2015: http://www.ons.gov.uk/ons/rel/rdit1/gross-domestic-expenditure-on-research-and-development/2013/stb-gerd-2013.html

Figure 11: BERD intensity broken down by most important macro-sectors: C= manufacturing, G_N=services



The private sector is the main funder of the UK BERD as below. Given that both the external (abroad) and the government sector was a rather stable funder (0.09% of GDP - government, 0.24% of GDP – external sector) fluctuations in BERD stem mainly from variations of the funding from the private sector. This has been on a very slightly ascending path from its 2005 level of 0.65% of GDP reaching 0.77% of GDP in 2014.

Figure 12: BERD by source of funds



3.6.2 The development in business R&D intensity by sector

The highest BERD spenders in the manufacturing sector are high-technology (computer, electronic and optical products, C26), or medium-high tech (automotive industry, C29 and the machinery and equipment sector, C28) sectors. Companies such as Square Enix and Amdocs, Arm holdings and CSR UK, Delphi and GKN are among the larger UK enterprises conducting R&D[54].

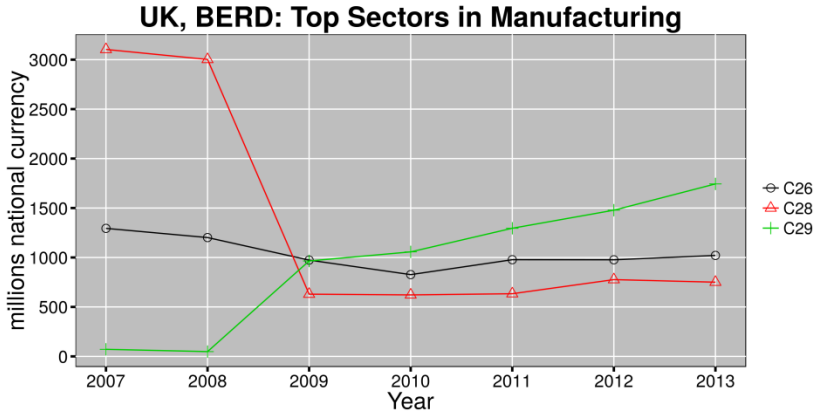
During the 2008 financial crisis the machinery & equipment BERD seems to have suffered an important one-off loss in 2009 which could be due to an R&D site closure, offshoring or other factors. While UK manufacturing in general showed increasing levels of productivity due in part to R&D investment, the UK overall has very low non-R&D investments[55], which impacted on machinery and equipment after the crisis in a period

[54] http://iri.jrc.ec.europa.eu/scoreboard.html
[55] EU Innovation Union Scoreboard data

of very low investment where new plants and machinery could not be financed. Since then, BERD in this sector has registered small fluctuations around an average yearly value of £682m. On the other hand, the automotive industry BERD increased spectacularly during the same year. It has remained on an ascending path ever since showing strong and steady growth with a compound average growth rate (CAGR) of 15.9%. The automotive industry is backed by government in its industrial strategy and has received investments in production facilities in recent years. BERD in the computer & electronics sector decreased by around 30% in 2008-09 stabilising at around £1,000m since.

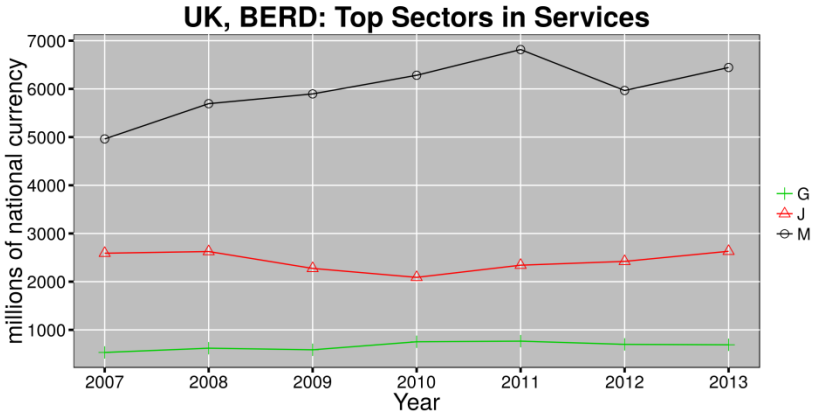
Figure 13: top sectors in manufacturing:

C26= computer, electronic and optical products; C29=motor vehicles, trailers and semi-trailers; C28=machinery and equipment).



In the business services sector, professional, scientific and technical activities, ICT, as well as wholesale & retail are the top BERD receivers in this order. Professional activities BERD has been growing steadily and rather strongly (CAGR: 8.3%) between 2007 and 2011. However, this growth turned into a steep fall in 2012 of 12.5% followed again by a growth in 2013 in line with the above mentioned average growth of 8%. The reasons for this one-off fall are still unclear. ICT BERD decreased during the crisis but has recovered since and managed to surpass its 2008 level in 2013 for the first time.

Figure 14: top service sectors:
J=information and communication,
G=wholesale and retail trade, M=professional, scientific and technical activities

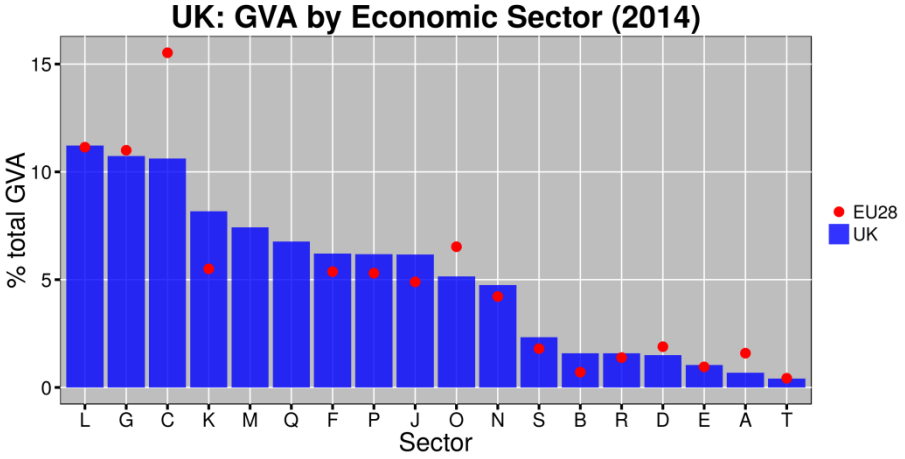


3.6.3 The development in business R&D intensity and value added

Looking at the contribution of the various sectors to the total gross value added (GVA), wholesale and retail trade, real estate activities, as well as manufacturing, were the top three sectors providing the highest GVA to the UK economy in 2011. These are obviously the largest economic sectors, with above 10% shares in GVA. They are followed by financial activities, health industry and professional activities with a share of 7-8% in total GVA each.

Comparing these graphs, wholesale and retail trade is both a top contributor to GVA and a top performer in BERD. However, large BERD receiver sectors like ICT or professional activities fail to be the among the top GVA contributors. One possible reason could be the relatively small size of the latter two compared to the former or to manufacturing as a whole. Real estate activities, financial services and the healthcare industry (excluding pharma) are not so important for the UK BERD, but they are among the top sectors in terms of GVA.

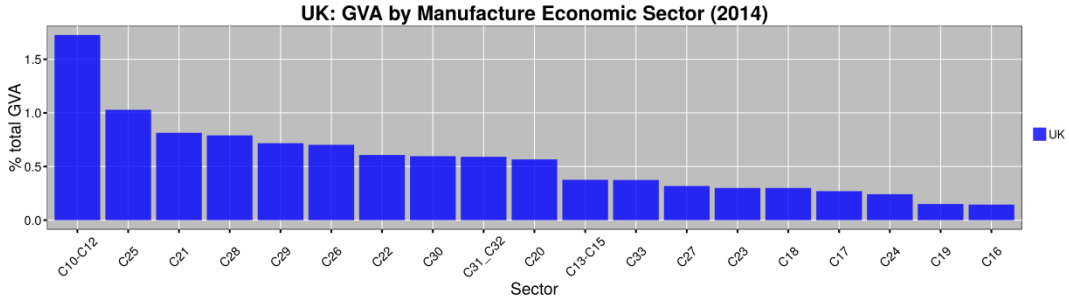
Figure 15: economic sectors as percentage of the total GVA
Top 6 sectors in decreasing order: 1) Wholesale and retail trade; 2) Real estate activities; 3) manufacture; 4) Financial and insurance activities; 5) Human health and social work activities; 6) Professional, scientific and technical activities.



The manufacture of food, beverages and tobacco appears to be the leading manufacturing service in terms of GVA, but still it accounts for only 1.5% of total GVA. This is followed by the pharmaceutical and the fabricated metal products GVA with only 1% of total GVA. Other sectors shares are below 1%. Consistently with its importance in the manufacture in terms of BERD, the machinery and equipment sector appears to be important also in the GVA. Apart from the food and beverages sector one observes mainly medium to high tech sectors among the top six.

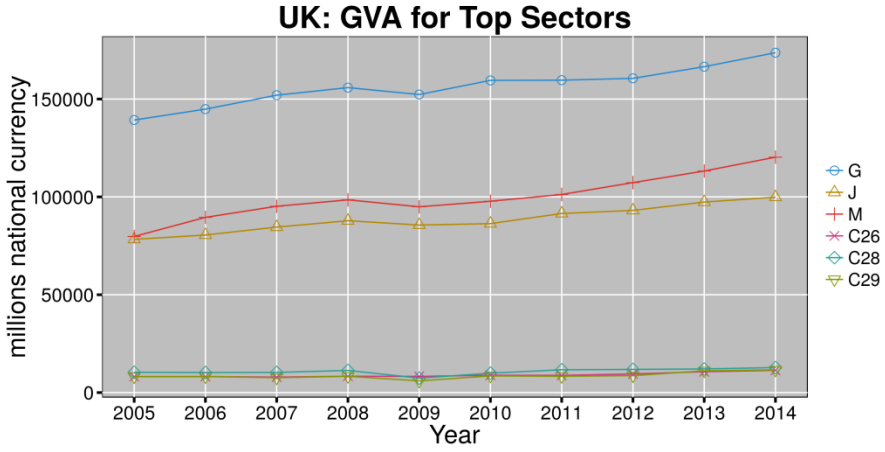
Figure 16: GVA in manufacturing.

Top 6 manufacturing sectors: 1) food, beverages and tobacco products; 2) basic pharmaceutical products and pharmaceutical preparations; 3) fabricated metal products, except machinery and equipment; 4) machinery and equipment; 5) chemicals, 6) computer, electronic and optical products



In line with the above discussion, the wholesale and retail as well as professional activities the information communication sectors are the top three in terms of G VA at factor cost. All three had an ascending trend between 2005 and 2011.

Figure 17: Value added for the leading sectors



The UK economy is characterised by a concentration of large firms and a broader number of much smaller enterprises. The UK's high-growth enterprise data shows an overall increase in the numbers of these types of companies across all six sectors. Employment trends are in line with the findings in this report – there is a slight increase in the number of STEM graduates employed in manufacturing, a stable level in wholesale and retail trade, and motor repair, while ICT has seen mostly increases since 2008, and professional, scientific and technical activities have also increased.

3.7 Assessment

Overall, the UK research system appears to function in an efficient manner. Given that the mechanisms by which institutional and project funding are allocated have been in place for considerable time and have remained relatively stable over that time, it may be assumed that they operate in a satisfactory manner. The effectiveness of these funding mechanisms is supported by the regular and periodic process of monitoring; review and evaluation to which all forms of support are subject. It should also be noted that the structure of this support system is by no means static – procedural changes are put in place as a consequence of the policy feedback processes noted above. However, any changes implemented are typically incremental rather than major and disruptive. For example, the review of the RAE which led the development of the REF (which is overall a very similar mechanism) addressed a number of concerns with regards to the allocation mechanism itself – it did not affect the balance between project and institutional funding.

There appears to be little impact concerning the balance between project and institutional funding for research, a balance which has remained largely static for several years. However, it may be argued that the current allocation mechanisms for both project and institutional funding are strongly predicated on the belief that scientific (taken in its broadest sense) quality is fundamentally linked to the production of publications in so-called 'high impact' journals. The recent introduction of the notion of 'research impact' (i.e. the broader and long-term social and economic effects of research) into the REF may help to differentiate the criteria used by both streams of funding.

4. Quality of science base and priorities of the European Research Area

Quality of the science base

The background Evidence Paper to 'Our Plan for Growth' (BIS, 2014b) notes that "the UK research base punches well above its weight on the global stage; with less than 1% of the global population and only 4% of the world's researchers, the UK accounts for 10% of downloads, 12% of citations and 16% of the world's most highly-cited articles (second only to the United States)". In addition, the UK exhibits strength across a broad range of major research fields and multidisciplinary competencies[56] and represents one of the most productive research bases in the world: in 2012, it "produced more articles and more citations per unit of expenditure than any other country in the G8 and was in the top three among comparator countries for articles and citations per researcher" (BIS, 2014b). When research quality is examined, the UK ranks in first place in field-weighted citation impact and scores over 50% higher than the world average in most fields (BIS, 2014b).

These findings are supported by figures see below. In all indicators, except one - international publications normalised for population size - the UK scores above the EU average. There is no simple, single explanation for this standard of performance although it is likely to be due to a combination of the UK's international reputation as a good place to undertake research, its stable research funding systems, world-class scientific infrastructures, stability of research careers, institutional autonomy and openness to foreign researchers, in addition to a domestic supply of well-educated human resources.

Table 9: Publications indicators – UK and EU data

Indicator	Year	EU
Number of publications per thousand of population	2.35 (2013)	1.43 (2013)
Share of international co-publications in total publications	48.9% (2013)	36.4% (2013)
Number of international co-publications per thousand of population	73,325 (2013)	262,593 (2013)
Percentage of publications in the top 10% most cited publications	15.95% (2010)	12.25% (2010)
Share of public-private co-publications	2.4% (2011)	1.8% (2011)

4.1 Optimal transnational co-operation and competition

4.1.1 Joint programming, research agendas and calls

The UK is an active and leading participant in several transnational initiatives that aim to promote information sharing, the development of joint research agendas, joint calls and joint programming. Examples include its participation in Joint Programming Initiatives (JPIs) and ERA-NET activities (see below). These align closely to national programmes, some of which address grand challenge issues and which are operated by the UK Research Councils, although the latter are more fully tailored to the national research capability and to priority UK concerns. UK Government representatives and other interested parties are active participants at a number of levels of EU policymaking concerning the complementarity of EU and national activities. Examples here include representation on bodies/initiatives such as the Open Research Area in Europe for the Social Sciences (ORA), where national proposals are administered by the ESRC, membership of Science Europe (with representation from all the UK Research Councils)

[56] Elsevier (2013). 'International Comparative Performance of the UK Research Base – 2013'

and of the Global Research Council (again through UK Research Council participation) (Cunningham, 2015).

UK participation in JPIs:

- Neurodegenerative diseases (Alzheimer) - Member
- Food Security, Agriculture and Climate Change (FACCE) - Coordinator
- Cultural Heritage and global change: a new challenge for Europe - Member
- Healthy Diet for Healthy Life - Member
- The Demographic change (More Years, Better Life) - Member
- Antimicrobial resistance - An emerging threat to human health - Member
- Connecting Climate Knowledge for Europe (Clik'EU) - Member
- Water Challenges for a Changing world - Member
- Healthy and Productive Seas and Oceans - Member
- Urban Europe - Global Challenges, Local Solutions – Associate[57]
- UK participation in ERA-NETS:
- Under FP6: 72
- Under FP7: 87

Figures on the share per Member State of total public funding in ERA-NET and ERA-NET Plus calls for a sample of calls launched in 2009 – 2014 show that the UK contributed 11.4% of the total (amounting to some €80.9m), second only to Germany (with 22.3%) (European Commission, 2014).

In addition to its high level of participation in EU Framework Programmes (see also Sections 2.1 and 3.3.2), the UK government is also participating in discussions towards increasing international participation in European initiatives and in evolving mechanisms for the interoperability of non-EU or Associated country participation in national programmes (Cunningham, 2015). For example, in 2013, RCUK signed a Lead Agency agreement with *Fonds National de la Recherche*, Luxembourg, enabling UK and Luxembourg researchers to submit joint proposals via the UK system. A further MoU has been signed with FAPESP (State of Säo Paulo Research Foundation) of Brazil. Both enable UK Research Councils to receive and assess collaborative proposals from eligible institutions on behalf of both organisations and avoid double jeopardy in funding applications, while simultaneously removing some of the barriers facing international research collaboration. The Agreements do not represent a separate stream of funding, but enable collaborative proposals between UK and Brazilian or Luxembourg-based researchers to be submitted to existing RCUK competitions. Another example concerns ELIXIR, the European Life Science Infrastructure for Biological Information Hub, which receives funds through the UK's Large Facilities Capital Fund via RCUK.

National funding is allocated according to a number of strategic criteria, largely defined by nationally-oriented priorities and demands, although the presence of European funding opportunities and activities will be taken into consideration, particularly when formulating the modalities through which funding to UK researchers may best be undertaken (Cunningham, 2015).

International peer review and best practice is already fully integrated into the evaluation and assessment systems and processes operated by the range of funding agencies in the UK, including those in the not-for-profit sector. However, national funding in the UK is allocated only on the basis of evaluations conducted at the behest and under the frameworks prescribed by UK funding bodies. Possible exceptions to this include international programmes which may require partial co-funding by UK bodies but where external evaluation processes are accepted (e.g. EU funding) (Cunningham, 2015).

[57] Review of the Joint Programming Process: Final Report of the Expert Group, 2012.

4.1.2 RI roadmaps and ESFRI

The UK is viewed as an example of good practice in terms of its policies towards the accessibility of research infrastructures. The UK Government is continuing to work through ESFRI and directly with the Commission to further realise the opportunities that could arise for the strategic planning and operation of such facilities, including access for non-national researchers, both within and outside Europe (Cunningham, 2015).

As noted by Cunningham (2015), the UK Government recognises the importance of providing investment in the appropriate research infrastructures. Hence, the 2013 spending review, pledged to increase the investment in infrastructure capital from £500m (c. €625m) p.a. to £1.1b (c. €1.4b) p.a. in 2021, an announcement that followed significant investment in recent years in e-infrastructure and in the 8 Great Technologies (Big Data, Space, Robotics, Synthetic biology, Regenerative medicine, Agri-science, Advanced materials and Energy). In 2012, the UK Research Councils published a capital investment framework[58]. To build on this, the Government carried out a consultation with the research community and other stakeholders to identify priorities for investment to 2021. The consultation included both institutional and regional based infrastructures but also where the UK could collaborate on an international basis, either as a host or part funding a facility based elsewhere. The outcome of the consultation was published by BIS in December 2014[59]. The 2014 Science and Innovation Strategy (BIS, 2014) refers to the consultation and notes that £5.9b (c. €7.9b) has been allocated to science capital from 2016 to 2021, marking the "longest commitment to science capital in decades". This will include investment of £2.9b (c. €3.87b) towards scientific grand challenges, including £1b (c. €1.3b) to projects such as a new Polar Research Ship and the Square Kilometre Array. A further £800m (c. €1,067m) will fund new projects, which include the Sir Henry Royce Institute for advanced materials; big data at the Hartree Centre, Daresbury, the European Space Agency programmes (including Britain's lead role in the next European Rover mission to Mars), a new Energy Security and Innovation Observing System, extending the capabilities of the National Nuclear Users Facility, an innovation centre on ageing, in Newcastle and the Alan Turing Institute (Cunningham, 2015).

With regard to the removal of barriers for access to UK research facilities, except in cases that may conflict with interests of national security, access to UK research infrastructures is open to all UK and non-UK nationals who are registered as UK academics (in a UK HEI or Research Council Institute); Postdoctoral researchers from UK universities; those applying via EU transnational access arrangements (the level of access is in accordance with agreed EU funding levels); overseas organisations that have contractual access agreements with the relevant facilities. In addition, applications from overseas (non-EU or without prior contractual access arrangement) will also be considered. Direct financial support for such access is generally not provided although support from schemes operated by the Royal Society and the Royal Society of Engineering may be sought by non-nationals (Cunningham, 2015).

4.2 International cooperation with third countries

As noted by BIS (2014b) the UK now forms a "partner of choice for research collaboration, with 48% of all UK articles in 2012 resulting from international collaboration; and, with almost 72% of active researchers internationally mobile in the period 1996-2012 the UK is well placed to continue to drive this research excellence into the future". It also notes the UK's long track record in this area, with the Research Councils and Higher Education Institutions' use of novel, multidisciplinary and collaborative approaches for the investigation of the big research challenges facing the

[58] http://www.rcuk.ac.uk/publications/policy/capitalinvestment

[59] https://www.gov.uk/government/consultations/science-and-research-proposals-for-long-term-capital-investment

UK and the rest of the world (BIS, 2014b). These include a range of, often longstanding support schemes for international cooperation, such as those operated by the Royal Society and British Council and the recently established Newton Fund, which will deliver £75m (c. €94m) of government funding each year from 2014 for 5 years[60]. As a specific example, the value of bilateral UK-China Research Council programmes has risen to £130m (c. €162.5m) whilst those with India have increased from £1m (c. €1.25m) in 2008 to £150m (c. €187.5m) in 2013 (HM Treasury and BIS, 2014).

With regards to the better coordination of the objectives and activities of the EU, MS and Associated Countries towards third countries and International Organisations, the views of RCUK are that "There is a need for a more strategic and inclusive approach to international co-operation within the Framework Programme. This does not mean a rigid plan imposed by the Commission or standalone groups with limited membership such as SFIC, but a more coherent framework under which international co-operation activities can thrive and feed back into the Commission's activities. Funding for third country participation should continue to be available from within each sub/thematic programme"[61].

There are no major apparent institutional barriers that hinder access to the labour market by foreign researchers and language barriers tend to be minor: in fact, the English language is seen to be an attractant for researchers from overseas. While calls for greater restrictions on the granting of visas for foreign workers and students, prompted both by concerns over terrorism and levels of immigration have led to debate over their implications for UK university recruitment, UK universities have emphasised the value of both overseas students and staff in order to ensure that potentially deleterious effects of any policies for visa restrictions are ameliorated[62]. In addition, since April 2014, Research Councils UK has been cooperating with the Royal Society, British Academy and Royal Academy of Engineering, in the piloting of a streamlined endorsement process in order to make it easier for outstanding international researchers who have been awarded Research Councils funded fellowships to obtain a Tier 1 Exceptional Talent visa[63] (Cunningham, 2015).

The UK also participates in the further development of the Multi-Annual Roadmaps for international cooperation: for example, in the area of fusion energy it is strongly involved in third country collaboration at the Joint European Torus (in Culham) enhancement project in support of ITER.

4.3 An open labour market for researchers

4.3.1 Introduction

The UK is characterised by a high degree of institutional autonomy with regard to the mobility, appointment, training and career enhancement of researchers. There were 259,347 full-time equivalent (FTE) researchers in the United Kingdom in 2013. This represents 8.6 researchers per 1000 labour force compared with an EU average of 7.4. Eurostat figures indicate that there scientists and engineers made up 6.6% of the total population in 2014, compared to an EU average of 4.3%[64]. The total number of researchers has grown steadily for several years, although it fell slightly in 2008 and again in 2011 (ONS).

[60] See: https://www.gov.uk/government/publications/newton-fund-building-science-and-innovation-capacity-in-developing-countries/newton-fund-building-science-and-innovation-capacity-in-developing-countries

[61] http://www.rcuk.ac.uk/RCUK-prod/assets/documents/international/RCUKresponseoCSFRIGreenPaper.pdf

[62] For example, see: http://www.universitiesuk.ac.uk/highereducation/Pages/PresidentsAddress2013AnnualConference.aspx

[63] http://www.rcuk.ac.uk/media/news/140403/

[64] http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do

4.3.2 Open, transparent and merit-based recruitment of researchers

UK HEIs have full autonomy in the design and implementation of their recruitment policies, although they are required to publish all relevant policies on their websites. Recruitment for new staff follows institutional guidelines and any additional stipulations set by the funding source (for example, Research Council grants). The UK higher education funding bodies encourage action to ensure openness and competitive recruitment processes – e.g. the Higher Education Funding Council for England (HEFCE) encourages institutions to have formal human resources strategies and provides funding to support these strategies under the Rewarding and Developing Staff in HE initiative. HEFCE also encourages institutions to develop recruitment and retention schemes (Cunningham, 2015).

The UK research base is very open and has been visibly successful in attracting researchers from both EU and other countries. For example, 12.9% of those studying at doctoral (research) level in the UK are from EU Member States and 28% are from other countries. There are also significant numbers of early career researchers, academic post holders and research fellows from other countries. Overall student numbers for 2010-11 show that there were 2,061,410 from the UK, 132,550 from other EU member states and 302,680 from the rest of the world (over half of these – 188,525 – coming from China or India) (European Commission, 2014a).

As noted by Cunningham (2015), the UK approach to open appointments, support for career development and other matters recognised as making a research career more attractive generally constitutes best practice. This approach is set out in the UK's Concordat to Support the Career Development of Researchers, which is referenced in the ERA Communication as an example of a Member State transposing the Charter and Code into their national contexts with notable results. Other measures include the dedicated web-based recruitment site (www.jobs.ac.uk): posted advertisements are accessible worldwide and the site is subscribed to by the major research actors in the UK, as well as European, North American and Commonwealth Universities. Many UK research institutions also advertise vacancies through the EURAXESS jobs website[65].

The UK meets the majority of the criteria for Transparent, Open and Merit-based recruitment, the only exceptions being the publication of the composition of selection panels (although, where such publication does not occur, information would be made available to the applicant) and the right to appeal (which is nonetheless granted in the case of alleged discrimination).

UK HEIs and Public Sector Research Establishments (PSREs) are also afforded the necessary autonomy to organise their activities in the areas of education, research, and innovation. They are able to draw on a number of income streams that includes alternative sources of funding such as philanthropy (the UK medical charities represent a major source of research funding) and commercial activities, together with income from endowments and investments.

An international benchmarking report from BIS (2014) notes that "the UK's main strengths include an ability to attract international students, a large number of doctorate holders and a rapidly growing population with tertiary education. This suggests good availability of human capital at the high end of the educational spectrum"[66]. In addition, the UK National Action Plan on researcher mobility and careers within the ERA (2009) points out that the UK research base is already one of the most open in the world both as regards recruitment of researchers and scientific collaborations (over 40% of UK scientific papers now have one or more non-UK co-authors) and the UK Government

[65] http://ec.europa.eu/euraxess/index.cfm/jobs/

[66] International Comparative performance of the UK research Base – Elsevier. Available at: http://www.bis.gov.uk/assets/biscore/science/docs/i/11-p123-international-comparative-performance-uk-research-base-2011

funds a number of dedicated fellowship schemes which seek to attract the best early career researchers from around the world to UK institutions. The majority of the fellowships are open to UK and overseas candidates regardless of nationality, and candidates are assessed in competition with each other (Deloitte, 2014).

In terms of outward mobility, many of the UK Research Council fellowships have a strong international element and international collaboration is actively encouraged as part of the process of building an international reputation. Many awards include the option of undertaking research training outside the UK.

Figures from the Higher Education Statistics Agency (HESA)[67] note that while a large proportion of students studying in the UK (2013/14) were domiciled in the UK before they entered Higher Education (81.1%), a further 5.4% were from other countries within the EU and 13.5% were from countries outside the EU. The proportion for postgraduate students is higher: "over half (57.8%) were from outside the UK, with 46.4% of full-time postgraduates coming from outside the EU. Non-UK postgraduate students were prominent on full-time research degree courses (50.5%) and even more so on full-time taught higher degree courses (70.2%)".

Finally, in 2012, 28% of UK researchers were employed on fixed-term contracts, compared to an EU average of 34.3% (Deloitte, 2014). HESA data indicates a slightly different picture within the HE sector: 124,825 (64.2%) of UK academic staff was employed on open-ended or permanent contracts in 2013/14 compared to 69,415 (35.7%) on fixed term contracts. These figures represent a slight improvement over 2011, when the proportions were 63.8% and 36.2% respectively[68].

According to a survey (MORE 2 Survey, 2012), 78 % of university-based researchers were satisfied with the extent to which research job vacancies are publicly advertised and made known by their institution .

4.3.3 Access to and portability of grants

With regards to access to cross-border grants, the majority of the Research Council and other fellowships are open to UK and overseas candidates regardless of their nationality: applicants are assessed in competition with each other (Deloitte, 2014).

Regarding the portability of grants, researchers of all nationalities, who have been appointed to an eligible research post at a UK University, can apply for a Research Council grant. Grant portability is a matter for the individual UK funding agencies in collaboration with their partners elsewhere. Individual UK Research Councils have bilateral arrangements which allow for grant portability with specific partner research funding bodies both within Europe and beyond. Individual UK Research Councils have signed the EUROHORCS 'Money follows researcher' letter of intent, which allows them to create bilateral arrangements with foreign universities within Europe and beyond, and accept grant portability with homologous research funding bodies. However, since EUROHORCS no longer exists, the UK Research Councils are in the process of signing up to the Science Europe Money follows researcher letter of intent. This will allow researchers funded by UK Research Council grants to "continue their funded research upon moving to another participating European country. The grant can then be continued at the new research institution within the original terms and objectives"[69]. In addition, the Academic Visitor Visa programme allows academics from overseas to travel to the UK for up to 12 months (including multiple entries) when taking part in formal exchange agreements with UK counterparts or carrying out research whilst on sabbatical leave from their home institution.

[67] https://www.hesa.ac.uk/intros/stuintro1314
[68] https://www.hesa.ac.uk/pr/3704-press-release-220
[69] http://www.mrc.ac.uk/research/international/other-international-funding-activities/

4.3.4 Doctoral training

All UK Research Councils base the allocation of funding for doctoral training on the quality of applications. This is a result of the need for prioritisation and a firm policy objective of improving the quality of doctoral training in the UK and striving for excellence. Research Councils UK has developed a Statement of Expectations for Doctoral Training[70] which lays out common principles for the support of all Research Council students. These principles are aligned with the seven principles for Innovative Doctoral Training[71] (Deloitte, 2014).

Although there are no specific individual measures that address the principles for Innovative Doctoral Training as stipulated by the ERA Communication, the practices and principles espoused by the Research Councils for the recruitment and training of researchers (for example, the Terms and Conditions of Research Council Training Grants) collectively address the full range of the ERA Communication's principles and set out conditions that must be adhered to by grant-holding institutions. Similarly, the QAA Code of practice includes a joint statement of skills that doctoral research students funded by the Research Councils are expected to develop during their research training.

In addition, the Concordat to Support the Career Development of Researchers (see below) states that "Researchers are equipped and supported to be adaptable and flexible in an increasingly diverse, mobile, global research environment" (Principle 3) and recognises the need to support researchers in developing professional skills that they will need to be both effective researchers and highly skilled professionals in whatever field they choose to enter. Signatories to the Concordat have also committed to ensure that "the importance of researchers' personal and career development, and lifelong learning, is clearly recognised and promoted at all stages of their career" (Principle 4).

The UK Research Councils use three major mechanisms to support doctoral training comprising Doctoral Training Partnerships (DTP), Centres for Doctoral Training (CDT) and Collaborative Studentships (e.g. CASE awards)[72]. Doctoral Training Partnerships provide training for students across a broad range of subjects determined by a Research Organisation or consortia of Research Organisations. Partnerships involve strategic engagement between the Research Organisation(s) and the Research Council funder(s) in developing the overall programme of training. The DTP model is used by all seven UK Research Councils.

Centres for Doctoral Training were first established by the Engineering and Physical Sciences Research Council (EPSRC) which funds the majority of these centres. More recently, the Arts and Humanities Research Council (AHRC) and the Natural Environment Research Council (NERC) have also adopted the DTC model. Some DTCs are associated with the themes of the RCUK cross-cutting programmes and some are joint between EPSRC and one of the Medical Research Council (MRC) Biotechnology and Biological Sciences Research Council (BBSRC) or the Economic and Social Research Council (ESRC). Each CDT involves a UK university (or a small number of universities) in delivering a four-year doctoral training programme to a significant number of PhD students organised into cohorts. Each Centre targets a specific area of research, and also emphasises transferable skills training.

Collaborative Training provides doctoral students with a first-rate, challenging research training experience, within the context of mutually beneficial research collaboration between academic and partner organisations in the private, public and civil society sectors. The term 'industrial' is sometimes used as a short-hand for these awards, although they are relevant to all non-academic partners including industry, business, public and third/civil society sectors.

---

[70] http://www.rcuk.ac.uk/researchcareers/postgrad/Pages/home.aspx
[71] http://ec.europa.eu/euraxess/pdf/research_policies/Principles_for_Innovative_Doctoral_Training.pdf
[72] http://www.rcuk.ac.uk/RCUK-prod/assets/documents/skills/RCUKCommonTerminologyforPostgraduateTraining2013.pdf

4.3.5 Gender equality and gender mainstreaming in research

The issues of gender equality and gender mainstreaming are addressed under the principles of the Concordat to Support the Career Development of Researchers, along with the QAA Code of Practice for research degrees, both of which are firmly endorsed by the UK.

The UK Quality Assurance Agency (QAA) for Higher Education aims at "safeguarding standards and improving the quality of UK higher education". The UK Quality Code for Higher Education (the Quality Code 2012/13) has replaced the previous Code of Practice introduced in 2004 and is used to assure the standards and quality of UK higher education. In addition, the Concordat to Support the Career Development of Researchers (2008) constitutes an agreement between the employers (universities) and research funders (Research Councils, funding councils, major charities, etc.) on good management and quality working conditions for research staff.

A UK-wide process enables UK HEIs to gain the European Commission's HR Excellence in Research Award, which acknowledges their alignment with the principles of the Charter and Code. The UK process incorporates both the QAA Code of Practice for Research Degree Programmes and the Concordat to Support the Career Development of Researchers to enable institutions that have published Concordat implementation plans to gain the award. The UK approach will include on-going national evaluation and benchmarking. As of July 2015, 93 UK HEIs have now qualified for HRS4R acknowledgement and the European Commission's "HR Excellence in Research" badge[73].

The Royal Society and the Royal Academy of Engineering (RAE) are jointly leading a programme to tackle the long-standing issue of diversity in science, technology, engineering and maths (STEM). Many of the Government's other STEM partners are also contributing directly to the equality and diversity agenda; for example, the work of the National Academies and their academic fellowships; RCUK's PhD and fellowship awards; and STEMNET and STEM Ambassadors. In addition, the Athena SWAN Charter recognises good employment practice for women working in science, engineering and technology in higher education and research. In addition, the National Institute for Health Research has mandated Athena SWAN Silver accreditation for funding for Biomedical Research Centres and Units and RCUK has set out a Statement of Expectations for Equality and Diversity to improve progress in this area (Cunningham, 2014). Recently, under the BIS-funded STEM Diversity Programme the RAE has established a Diversity Leadership Group comprising senior representation from 38 engineering businesses, while the The Royal Society has published a study on the business case for equality and diversity and a major data study on the makeup of the UK scientific workforce (BIS, 2015a).

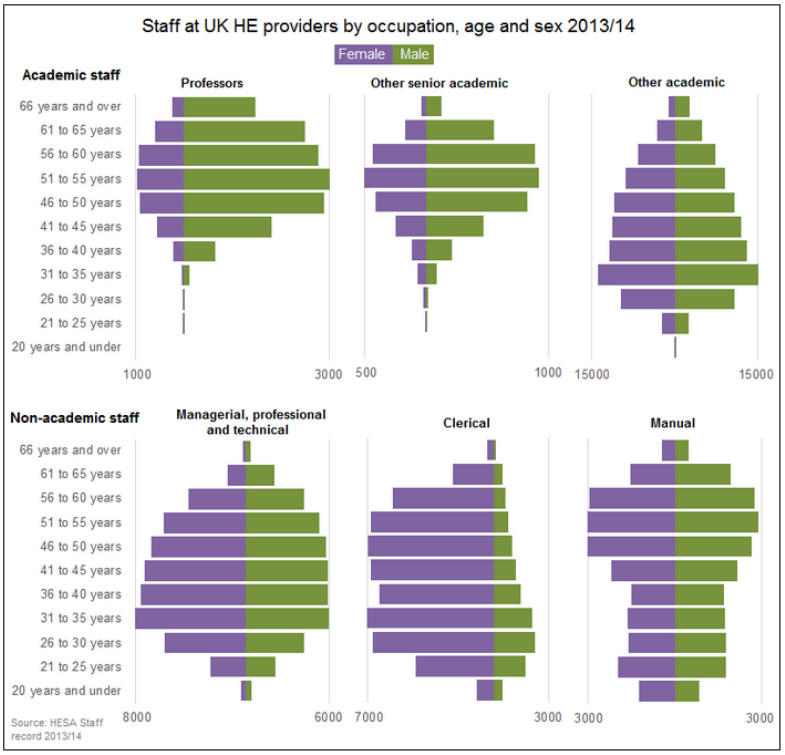
In practical terms, UK HEIs have legal requirements to monitor and publish data as part of the public sector equality duty (PSED) of the Equality Act 2010. Similar provisions apply to HEIs in Northern Ireland through section 75 of the Northern Ireland Act 1998. The specific duties underpinning the PSED include requirements to:

- Publish information about how their functions affect staff and students with different protected characteristics
- Set measurable equality objectives (or outcomes in the case of Scotland) to meet the duty
- In Scotland and Wales, institutions are also required to develop an evidence base of equality information to:
- help assess the equality impact of policies and practices
- inform the development of equality objectives (or outcomes).

[73] https://www.vitae.ac.uk/news/press-releases/hr-excellence-in-research-award-achieved-by-two-more-uk-universities-and-six-further-retained

HEIs also have a statutory obligation to submit certain data to the Higher Education Statistical Agency (HESA). Currently higher education institutions are required to return data on staff and students' sex, race/ethnicity, disability and age as part of their annual staff and student records. Recent data on gender and age distributions at UK HEIs are provided below.

Figure 18: UK HE Staff by female-male breakdown, 2013-2014



Eurostat figures for 2014 indicate that, of a total of 11,074,00 persons employed in S&T aged between 17 and 74, 5,595,000 were male and 5,480,000 were female[74].

4.4 Optimal circulation and Open Access to scientific knowledge

4.4.1 e-Infrastructures and researchers electronic identity

Both the UK Research Councils and British industry recognise the importance of digital infrastructures and the positive impact they may have on the economy and on employment. In November, 2011, the UK published a Strategic Vision for UK e-Infrastructure[75], followed this with an update in 2013[76], and is in the process of investing £165m (c. €200m) to strengthen the UK's e-infrastructure in collaboration with industry. The report also notes that "the UK Government is currently spending approximately £200m p.a. (c. €256m) on aspects of e-infrastructure to support the academic community".

Specific measures include the Research Councils' Gateway to Research which aims to provide a mechanism for businesses (particularly innovation intensive SMEs) and other interested parties to identify potential partners in universities to develop and commercialise knowledge, and maximise the impact of publicly funded research (see below).

[74] http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do
[75] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/32499/12-517-strategic-vision-for-uk-e-infrastructure.pdf
[76] 'E-infrastructure: the ecosystem for innovation - one year on'. Available at: https://www.gov.uk/government/publications/e-infrastructure-ecosystem-for-innovation-one-year-on

In March, 2102 the UK Government set up an e-infrastructure Leadership Council (ELC) to advise on all aspects of e-infrastructure including networks, data stores, computers, software and skills. RCUK is also currently developing its own complementary integrated set of priorities for e-infrastructure for research, and will work closely with the ELC to ensure linkage. Six areas are being tackled: Computer systems, software, data, skills, authentication and security, and networks. The UK National Research and Education Network, Janet, is a specialised internet service provider dedicated to supporting the needs of the research and education communities within the country. Jisc (formerly the Joint Information Systems Committee but now a private entity with charitable status) has also launched the UK Access Management Federation for Education and Research, which provides a single solution to accessing online resources and services for education and research.

Concerning the preservation of scientific information, the UK is at the forefront of advancing this topic within Europe. The UK Research Councils have already invested in a number of successful repositories. Notable examples include the Economic and Social Research Council's Research Catalogue funded by the Medical Research Council, the Biotechnology and Biological Sciences Research Council, the Chief Scientist's Office, part of the Scottish Government Health and Social Care Directorates and other funding bodies. However, since May 2014, no new data has been added to the catalogue and the RCUK Gateway to Research[77] now provides details of more recent grants and outputs.

The RCUK Gateway to Research aims to provide a mechanism for businesses (particularly innovation intensive SMEs) and other interested parties to identify potential partners in universities to develop and commercialise knowledge, and maximise the impact of publicly funded research. The initiative is being developed as part of the BIS Innovation and Research Strategy. The live system was launched at the end of 2013 and the open and free website has been developed using Open Source, Open Standards and an Open Government Licence (OGL), to enable the code to be reused by third parties. Gateway to Research is intended to give the public better access to information on research funded by the Research Councils, particularly information such as:

- who, what and where the Research Councils fund and
- the outcomes and outputs from Research Councils' funding, linking to already available open access repositories and/or data catalogues.

It also contains information on the outcomes, outputs and impact held on RCUK's Research Outcomes System (ROS)[78] and the Medical Research Council's ResearchFish[79], and links to other available open access repositories and data catalogues. As of September 2014, all seven Research Councils now use ResearchFish, and it is currently used by over 90 research funders to gather information from researchers about the outcomes of their work.

The UK Government is currently exploring the implications of an electronic identity for researchers. The Joint Infrastructure Systems Committee (JISC) representing UK universities has led a project in collaboration with UK research stakeholders to investigate the best way to promote unique identifiers for researchers, and therefore have a better way of tracking their contribution and career paths. The project outcomes recommended the adoption of the Open Researcher and Contributor Identifier (ORCID), which currently offers the best sustainable solution. The implementation of such system does raise a number of challenges, such as identity validation and identity tracking, as well as protection of personal data, but a number of UK universities have perceived the benefits to outweigh the issues, and have already adopted ORCID, which has received the support of the Higher Education Statistics Agency. In January 2015, JISC held a pilot workshop (attended by representatives from the 8 pilot HEIs, and several other UK HEIs,

[77] http://gtr.rcuk.ac.uk/
[78] http://www.rcuk.ac.uk/research/researchoutcomes/
[79] http://www.mrc.ac.uk/funding/guidance-for-mrc-award-holders/researchfish/

ORCID, HEFCE, RCUK, UCISA, The Conversation, system vendors, developers, ARMA and the ORCID Wikimedian in Residence) It is now preparing the next steps for ORCID adoption post the HEI pilot phased [80] and developing plans to coordinate ORCID consortium membership for the UK.

4.4.2 Open Access to publications and data

One example of the UK's approach to data preservation is the UK Data Archive. This represents a leading international example of data curation and sharing and curates the largest collection of digital data in the social sciences and humanities in the UK. Established in 1967 by the then Social Science Research Council (now the ESRC), "with a long-term commitment of funds, the Archive collects data from surveys, questionnaires and interviews, with the aim of allowing researchers in one area to exploit already existing data sets arising from other areas of research. Since 2005, the British National Archives have designated the Data Archive to curate public records. The UK Data Archive acquires data from academia and public administrations as well as commercial sectors. It provides continuous access to the data acquired and promotes the creation of data user's communities. The UK Data Archive manages the UK Data Service, a portal for research resources that hosts survey data collections, databanks, census data and qualitative data in a secure manner. The UK Data Archive is constantly involved in data management and preservation initiatives, and it provides data curation for third organisations" (OECD, 2015).

The UK Government announced in July 2012 that it will make publicly funded scientific research available for anyone to read for free, by accepting all of the recommendations in the independent report on open access – the Finch Report[81], published in June 2012. The report concluded that the most effective way to deliver OA was through the 'gold' open access model in which Article processing Charges (APCs) are paid upfront to cover the costs of publication. Arrangements are being put in place to make publicly funded scientific research available for anyone to read for free: around 45% of such research will be available in 2013-14, increasing to over 50% in the following year. The Finch working group undertook a review of progress in implementing the report's recommendations in November 2013 [82] . According to data from the European Commission[83], the UK is one of the EU countries that least uses Gold Access journals (7.2%), although its overall access percentage is 55.9%, which places it eight overall in the EU27. The UK Research Councils have developed guidelines stating that publicly funded research must be available, preferably by means of gold open access, but green open access is an acceptable option. The UK Research Council guidelines also include specification of which copyright licence to use in the case of gold open access. In addition, open access constitutes a key component of the contribution of BIS to the UK Government Transparency Agenda and the guidelines developed by BIS were informed by the UK National Working Group on Expanding Access to Published Research Findings. BIS is also active in developing metrics and analysis to assess the costs and benefits of open access policies (OECD, 2015)

In October 2014, the leading UK medical charities (Arthritis Research UK, Breast Cancer Now, the British Heart Foundation, Cancer Research UK, Bloodwise (previously Leukaemia & Lymphoma Research) and the Wellcome Trust) which collectively make up the Association of Medical Research Charities, announced the formation of the Charity Open Access Fund (COAF)[84]. This has been established for an initial two-year period, and will operate in a similar way to the Wellcome Trust's established scheme of block grants

[80] http://orcidpilot.jiscinvolve.org/wp/2015/02/03/next-steps-for-orcid-adoption-orcid-consortium-membership-for-the-uk/
[81] http://www.researchinfonet.org/wp-content/uploads/2012/06/Finch-Group-report-FINAL-VERSION.pdf
[82] http://www.researchinfonet.org/wp-content/uploads/2013/02/Final-version.pdf
[83] http://science-metrix.com/files/science-metrix/publications/d_1.8_sm_ec_dg-rtd_proportion_oa_1996-2013_v11p.pdf
[84] http://www.wellcome.ac.uk/About-us/Policy/Spotlight-issues/Open-access/Charity-open-access-fund/index.htm

to institutions to meet the costs of APCs for articles arising from projects funded by one of the consortium partners.

For universities, publishers, and other agencies, the major development was linked to preparations for implementing the policies for OA in the 2015 Research Excellence Framework, which take precedence over other policies. In parallel, these stakeholders provided evidence to the independent review of the implementation of RCUK's OA policies[85]. RCUK's policy statement declares that "Free and open access to publicly-funded research offers significant social and economic benefits. The Government, in line with its overarching commitment to transparency and open data, is committed to ensuring that such research should be freely accessible. As major bodies charged with investing public money in research, the Research Councils take very seriously their responsibilities in making the outputs from this research publicly available – not just to other researchers, but also to potential users in business, charitable and public sectors, and to the general public"[86].

The UK Government agrees that support for OA publication should be accompanied by policies to minimise restrictions on the rights of use and re-use, especially for non-commercial purposes, and on the ability to use the latest tools and services to organise and manipulate text and other content. Where APCs are paid to publishers, the Government expects to see unrestricted access to, and use of, the content.

According to the UK Open Access Implementation Group, (which includes the Research Councils, Universities UK, Research Libraries UK, the Wellcome Trust and a small number of universities), "a range of public and private sector organisations are committed to Open Access, and have (as appropriate) OA policies, statements of principle or relevant business models that are wholly supportive of OA. This, on its own, has not yet been sufficient to see a major shift toward OA in the UK higher education sector, despite the clear benefits that such a shift would bring. It is proposed that more effective and regular coordination between these organisations will lead to a significantly increased rate of movement toward OA in UK higher education".

The coverage of OA costs varies according to the body concerned. For example, the Wellcome Trust "will provide grant-holders with additional funding, through their institutions, to cover open access charges, where appropriate, in order to meet the Trust's requirements" , while "Funding for Open Access arising from Research Council-supported research will be available through a block grant awarded directly to research organisations". Furthermore, RCUK published the outcome of a comprehensive, evidence-based review of the effectiveness and impact of its Open Access policy in March 2015[87]. The review examined the implementation of the policy and its impact for UK HEIs, independent research organisations, learned societies and publishers, to ensure the policy is effective and provides clear guidance to the research community (see Section 2.2). Since the impact of OA policy on different disciplinary areas is likely to be varied, RCUK will permit different embargo periods across the disciplines supported by the Research Councils and will consider these differences when monitoring the impact of the policy and when looking at compliance.

[85] http://www.rcuk.ac.uk/research/openaccess/2014-independent-review-of-implementation/
[86] http://www.rcuk.ac.uk/research/openaccess/
[87] http://www.rcuk.ac.uk/research/openaccess/2014review/

5. Framework conditions for R&I and Science-Business cooperation

5.1 General policy environment for business

According to the World Bank "Doing Business Index 2105"[88], the UK scores relatively well on a number of indicators. The Table below shows rankings and 'distance to frontier - DTF' (% points) against the topics covered, for both 2015 and 2014.

Table 10: Distance to Frontier - UK data, Doing Business Index

Topics	Rank 2015	Rank 2014	DTF 2015	DTF 2014
Starting a Business	45	50	91.23	89.85
Dealing with Construction Permits	17	16	85.06	85.02
Getting Electricity	70	66	78.42	78.41
Registering Property	68	67	72.55	72.43
Getting Credit	17	14	75.00	75.00
Protecting Minority Investors	4	4	78.33	78.33
Paying Taxes	16	15	90.52	90.09
Trading Across Borders	15	17	88.32	88.24
Enforcing Contracts	36	37	68.08	68.08
Resolving Insolvency	13	13	82.04	82.04

Source: World Bank, 2015

'Starting a business' and 'Paying taxes' are topics that are reported as receiving recent reforms that make it easier to business, the former by speeding up the tax registration process and the latter by reducing Corporation tax in 2015. Despite some very minor upward and downward shifts in rank, in all topics the UK was either stable or registered a slightly positive DTF % between 2014 and 2015.

The 2014 Small Business, Enterprise and Employment (SBEE) Act made provision "to improve insolvency law to remove unnecessary costs and ensure effective oversight of insolvency practitioners so they deliver their services at a fair and reasonable cost that reflects the work undertaken". Provided the persons involved have been legally discharged from bankrupt status, they may start a new business. Thus, the UK helps businesses start again after non-fraudulent bankruptcy through measures such as a 1-year discharge or the removal of restrictions. Two separate registers, the individual insolvency register and the BRO (Business Restriction Order) register, enable people to differentiate between "culpable" bankruptcies and people who went bankrupt due to circumstances beyond their control. The UK Government also offers support with starting a new business following bankruptcy, including new business start-up grants or loans, but under certain eligibility conditions.

5.2 Young innovative companies and start-ups

Support for SME growth continues to represent a major priority in UK innovation policy. In particular, the specific tax credits scheme for SMEs provides a major focus of policy support and this is reinforced by a range of more tailored R&D support schemes which address the specific needs of SMEs. In recent years, there has been an increase in policy attention on a range of schemes aimed at mobilising financial support and investment, prompted in part by the desire to protect newly created and developing small companies from the effects of the financial downturn. Measures aimed at the creation of start-ups

[88] Available at: http://www.doingbusiness.org/data/exploreeconomies/united-kingdom/

and spin-offs also exist under the broad challenge of increasing the transfer of research results into economic outputs.

Examples of SME-focused measures include both direct support and measures to stimulate cooperation and knowledge sharing. Some of the main instruments are:

- R&D Tax Credits for SMEs (indirect support)
- Smart (direct support for R&D)
- Business Coaching For Growth; Manufacturing Advisory Service; Business Link; GrowthAccelerator; OpentoExport (Advisory support and capacity building)
- Enterprise Capital Funds; UK Innovation Investment Fund; Enterprise Finance Guarantee; Venture Capital Trusts; Business Angel Co-Investment Fund; Enterprise Investment Scheme; Seed Enterprise Investment Scheme; Business Growth Fund (Improvement of access to finance – particularly to mitigate effects of economic downturn).
- Leveraging of ERDF funding for innovation (targeted at firms in economically challenged areas)
- Innovation Vouchers (Access to range of services from science base providers)
- Launchpad (Targets SMEs in clusters)
- Small Business Research Initiative (Encourages SMEs to access government departmental procurement funding – demand-side measure)

Overall, SME support is delivered through a multimodal and flexible range of support measures addressing the spectrum of SME needs at both national and targeted regional/local levels. Measures tend to be tailored to the specific needs of SMEs and access is facilitated by a range of on-line approaches. Although there are no specific schemes that target SMEs in high-growth potential industries, schemes such as the Knowledge Transfer Networks tend to focus on important high technology areas and welcome participation by SMEs. Similarly, cluster-type measures (such as 'Catapults', Knowledge and Innovation Centres and Research and Innovation Campuses); also encourage participation by SMEs in specific technology sectors.

Attempts are made to reduce bureaucracy (e.g. the cabinet Office 'Red Tape Challenge'[89]) and to ensure that regulations do not create disadvantages to any businesses (e.g. the 'One-In, One-Out' rule[90] for new regulation). In common with all innovation support schemes, those for SMEs are regularly evaluated in order to assess their performance – international comparisons may be used where similar contexts exist.

With regard to entrepreneurs, in 2012 the Government introduced Start Up Loans to provide finance and mentoring to young entrepreneurs. By 2013, over £45m (€56.25m) of loans had been made to 10,000 entrepreneurs and the Government pledged a further £160m (€200m) to the scheme and extended it people of all ages. It is also now quicker and easier to register a business for tax: a new start-up can register as a limited company online in less than a day and the need for capital requirements has been removed.

The recent 'Productivity Plan' (HM Treasury, 2015) raises the issue of start-up growth capabilities: "Enterprise is not just about the number of start-ups. In fact, most new businesses are no more productive than existing businesses, even after 5 years. Raising the productivity of the whole economy depends on facilitating the growth of new and existing businesses with the greatest potential. But this is a relatively select group: typically, over a three year period, less than 1% of small and medium sized businesses will achieve high growth, although that same group will generate 20% of all job growth amongst established firms which grow". Thus, there seems to be a policy shift towards encouraging the development of innovative scale-ups. Two key requirements are outlined for this to occur - access to finance and building a stronger enterprise culture

[89] http://www.redtapechallenge.cabinetoffice.gov.uk/home/index/
[90] https://www.gov.uk/government/collections/one-in-two-out-statement-of-new-regulation

and improving management skills. Such measures are already in place but the Productivity Plan outlines ways in which these may be enhanced.

5.3 Entrepreneurship skills and STEM policy

Recent figures (HMT & BIS, 2014) note that the take up of GCSE (the qualification in a specific subject typically taken by school students in England, Wales and Northern Ireland, aged 14–16) in single sciences increased from 112,000 in 2010 to 129,000 in 2014 in Physics, from 113,000 to 130,000 in Chemistry and from 116,000 to 133,000 in Biology. In addition, the numbers of students taking STEM subjects in higher education have increased over recent years. Thus, total UK domiciled first degree enrolments at English HEIs (for all years between 2003-04 and 2012-13) have increased in biological sciences (from 85,300 to 122,000), in physical sciences (from 37,700 to 52,700), and in maths (from 17,100 to 26,500).

Current UK Government policy states that students should have opportunities for exposure to leadership, entrepreneurial training, internships and other workplace experiences, and careers guidance as an intrinsic part of the educational and vocational training. Moreover, teaching institutions should be accountable to their students for the quality of the delivery of these elements of education and training (HMT & BIS, 2014). The UK Government has made a "concerted and sustained effort" to improve the study of STEM subjects across the educational system, improve the rigour of the curriculum and accountability in schools, ensure that vocational education and apprenticeships are more responsive to the needs of employers, and to reform investment in undergraduate education. As noted in 'Our Plan for Growth', "a recent study by MIT identified that the UK has 3 of the top 5 of world's most highly-regarded university-based entrepreneurial ecosystems. However, it remains important that, in a harder and more competitive economic environment, we ensure the best exploitation of research for public benefit" (HMT & BIS, 2014).

At a wider level, a number of prize and challenge-led funding opportunities have been used to create opportunities for the stimulation of entrepreneurship and invention. One example includes the £10m (c. €12.5m) Longitude Prize launched in May 2014 by Nesta's Centre for Challenge Prizes, in which the goals were set through public vote. The prize seeks to find solutions to the problem of increasing microbial resistance to antibiotics. The Centre for Challenge Prizes was launched by BIS in 2012 and uses prize-giving initiatives to help solve problems that the business world, social and public sectors have so far either failed to tackle or tackle effectively[91].

Recent steps in this area include:

- Improvements to the National Curriculum with new programmes of study for science at Key Stages 1 to 3[92] (with a new programme for Key Stage 4[93] to be introduced in September 2016)
- New GCSE content criteria for science (which now includes an introduction to the human genome, life cycle analysis and space physics)
- New science A level specifications to strengthen mathematical and quantitative content to ensure students have the necessary numeric skills for undergraduate study
- Bursaries increased for postgraduate teacher trainees in STEM subjects
- £7.2m (c. €9m) funding over 2014-16 to provide support to science teachers through the National Science Learning Network
- Implementation of the Richard Review to reform apprenticeships and the introduction of Higher Apprenticeships at levels 4-7 to deliver the higher-level technical skills needed by employers

[91] See: http://www.nesta.org.uk/project/longitude-prize#sthash.C4r44qri.dpuf
[92] School years 1-9, typically to age 14.
[93] School years 10-11, typically to age 16.

- Establishment of high-status, employer-led National Colleges to deliver high level vocational education in strategically important sectors
- Lifting of the cap on student numbers and provision of £185m (c. €231.5m) funding to support the teaching of high cost subjects (science, engineering and technology) in higher education – to increase the flow of highly skilled graduates going into strategically important sectors of the economy. (HMT & BIS, 2014)
- Further plans include:
- The ambition for the overwhelming majority of young people in England to study mathematics at least to age 18 by 2020
- Allocation of £67m (c. €84m) for new training programmes for an additional 17,500 maths
- and physics teachers over the next Parliament
- Support for employers to develop and offer more Higher Apprenticeships in STEM areas
- Establishment of National Colleges in further key STEM sectors such as Digital Skills, Wind Energy and Advanced Manufacturing
- Provision of funding to HEFCE to develop and pilot engineering conversion courses for non-engineering graduates, in cooperation with the engineering profession
- Independent reviews of STEM degree accreditation arrangements to improve quality and graduate employability, starting with Computer Science accreditation
- Introduction of a major new loan system for postgraduate students.
- Dedicated support for women to return to jobs in industry following career breaks (HMT & BIS, 2014)

The Innovation Vouchers scheme, which provides grants up to €6,250 to SMEs, can be used to access a range of services from HE providers including training or coaching for staff.

5.4 Access to finance

Most of the measures aimed at the support of a strong venture capital market tend to focus on the supply of adequate finance to SMEs and early stage companies. The main sources of support are: Enterprise Capital Funds; UK Innovation Investment Fund; Enterprise Finance Guarantee; Venture Capital Trusts; Business Angel Co-Investment Fund; Enterprise Investment Scheme; and the Seed Enterprise Investment Scheme.

There are no specific incentives for investors to invest in limited partnership fund structures, although the tax treatment of carried interest in a typical private equity or venture capital fund is agreed in a memorandum of understanding between the British Venture Capital Association and Her Majesty's Revenue and Custom (the UK Government taxation authority). However, investment in private equity and venture capital more generally does attract fiscal incentives. Schemes, such as venture capital trusts (VCTs), Enterprise Investment Scheme and Seed Enterprise Investment Scheme aim to encourage investment in small and start-up companies by UK resident individuals and are eligible for tax incentive support. For example, investment of up to €237,265 in a VCT will attract tax relief of 30% provided it is held for at least 5 years. Moreover, any capital gains made on the sale of shares in a VCY will be exempt from Capital Gains Tax.

The British Business Bank, using its £300m (€375m) Investment Programme, is intended to promote greater diversity in the sources of lending to businesses, including mezzanine finance funds, supply-chain finance schemes, invoice finance platforms and peer-to-peer lenders. The Government, in conjunction with the Financial Conduct Authority has developed a regulatory framework to instil confidence amongst businesses and investors in new peer-to-peer and peer-to-business platforms. This came into effect in April 2014. In addition, the British Business Bank assists fast-growing businesses in accessing investment through initiatives such as the Business Angel Co-Investment Fund. Here, businesses can obtain equity investments of between £100,000 and £1m (€125,000 and €1.25m) in partnership with syndicates of business angels. The Bank also runs a number

of Enterprise Capital Funds which combine £487m (€608m) of public and private venture capital investment in high growth businesses.

According to the EVCA: "Tax benchmark study 2012"94, the two most commonly used fund structures available to private equity and venture capital investments are the English limited partnership (ELP) and the Scottish limited partnership (SLP) both of which are treated the same but which are legally distinct entities. Fiscal incentives are available at company level for: business R&D expenditure, R&D capital expenditure, contracting researchers, technology transfer and cooperative external research. They are not available for innovative spin-outs and young and innovative companies. The main rate of corporation tax is 20% regardless of size of company. No distinction is made for the nature of the enterprise (e.g. innovative start-up, high-tech, etc.). However, there are various fiscal incentives available for young innovative companies in the UK, such as enhanced R&D relief, more generous capital allowances, exemption from the UK transfer pricing rules, the EIS, VCT and SEIS schemes (see above), and Enterprise Management Incentive (EMI) share option schemes to encourage employee share ownership.

Venture capital and business angels networks

The *Enterprise Investment Scheme (EIS)* in the United Kingdom is in place since 1995 and is the most often cited example of a well-functioning angel investor tax incentive programme.

Main features of EIS:

- EIS income tax relief has been raised to be in line with Venture Capital Trusts, with the amount of upfront income tax relief increasing from 20% to 30%. The amount of investment that can attract upfront tax relief was doubled in April 2012 from 500 000 to 1 M £, limited to income tax liability if less than this. Investment can also be carried back and set against the previous year's income tax liability instead if desired.
- Capital Gains Tax (CGT) deferral relief: a capital gain from any asset can be deferred to the extent that the proceeds are invested in shares of a company that qualifies under EIS. The deferral lasts until the EIS shares are disposed of, or there is some other chargeable event.
- Any gain from the disposal of the shares in the EIS Company is exempt from CGT after 3 years. Inheritance tax exemption after 2 years.
- EIS rules and benefits apply directly if the participation occurs in a syndicate or as part of an Angel Co-investment Fund. EIS applies only to business angels paying taxes in the UK and investee companies must have a permanent establishment in the UK.

The programme has been evaluated every five years and, each time, the thresholds have been increased and the programme tweaked to help it more effectively reach its intended goals. Following a review in early 2013, the United Kingdom government increased the taxation relief available to investors in EIS schemes up to 30% on the amount invested. A NESTA study conducted in the United Kingdom a couple of years ago showed that 80% of investors surveyed used the Enterprise Investment Scheme (EIS) at least once and 57% of investments made use of EIS. In addition, investors indicated that 24% of investments would not have been made without EIS. Earlier evaluations of EIS were also positive and suggested significant additionality in terms of the amount of money invested (over 50%) as well as a positive impact on the companies in which they invested (Mason, 2009). There is currently a proposal to enhance the EIS referred to above with a scheme specifically targeted at Business Angels, the Seed Enterprise Investment Scheme (SEIS).

[94] http://www.evca.eu/uploadedFiles/Benchmark2012.pdf?dm_i=1GLS,1K23D,827W8K,5C4G8,1

5.5 R&D related FDI

According to 'Our plan for growth', the UK sees the attraction of R&D investment into the UK as a way to help to create high-skilled jobs and develop intellectual capital. Figures indicate that the UK performs well: in 2011 it attracted almost $7bn (c. €5.2bn) of overseas-financed R&D, equal to that attracted by Canada, Finland, Japan, China and Russia combined, more than either France or Germany ($4bn (c. €2.96bn) each) and just under half of that of the USA ($16bn (c. €11.9bn)). Nevertheless, more effort is needed since research commissioned by UK Trade and Investment (UKTI) indicates that while UK innovation is perceived internationally as excellent in science, it is weak in terms of commercialisation. Consequently, the UKTI Innovation Gateway was established in March 2014 as a means to address this issue. Intended to offer an easy access point for international investors, the Innovation Gateway will "create tailored investment portfolios and propositions on science and innovation for large international funds and corporates, whilst supporting innovation-focused UK companies in the 8 Great Technologies to internationalise and grow". The Gateway operates as a commercially focused organisation and works in partnership with Innovate UK, the Research Councils, the Foreign Office's Science and Innovation Network, and other stakeholders (HMT & BIS, 2014). Since its creation, the UKTI Innovation Gateway has provided support for over £485m (c. €606m) in FDI and R&D investment and has supported more than £160m in business deals for UK companies in the 8 great technologies. In addition, the Innovation gateway leads the UKTI Venture Capital network, which has supported more than £97m (c.€122m) in venture capital investment in early stage innovation-led businesses (HMT & BIS, 2014).

As a related topic (and also relevant to Section 5.3), UK Trade and Investment (UKTI) operates two programmes that aim to attract foreign entrepreneurs to set up businesses in the UK. The Global Entrepreneur Programme (GEP) operates through 'dealmakers' - established entrepreneurs who work part time for GEP – who are able to utilise their experience and networks to help client businesses grow through the provision of services such as advice on relocating, tailored mentoring on developing the business proposition and guidance on raising investment, at no cost to the client. Since 2004, GEP has helped to relocate over 390 businesses, creating more than 3,000 UK jobs. In 2014-15, GEP delivered 89 inward investments from 30 different countries, on projects ranging from developing smart cells for use in the 3D printing of organs for transplant, to carbon capture and storage technology. UKTI's Sirius Programme aims to encourage the world's brightest graduate talent, with world-class start-up ideas, to relocate and establish a business in the UK. Sirius is run as an annual competition and targets graduates with innovative business ideas who are either resident overseas or have studied in the UK. Overall, Sirius has received 2,200 applications from 93 countries, from which 75 start-ups were selected – 50% of which were outside London. The programme offers a 12-month place at one of five accelerators across the UK including office space, mentoring, financial support, and visa endorsement. Since the programme began in 2013, £3.6m (c. €4.5m) in equity investments has been raised and more than 50 jobs created (UKTI, 2015).

5.6 Knowledge markets

The UK's Intellectual Property Office (IPO) is responsible for the intellectual property (IP) framework in the United Kingdom for patents, trademarks, designs and copyright. An effective and fair IP framework is essential to support the translation of the results of research into innovative products, processes and services: the UK IPO has "a strong international reputation for the quality of the services [it delivers] and the contribution [it makes] to international thinking on global and European IP policy challenges"[95]. The UK IPO is an executive agency of BIS. Its aim is to "promote innovation by providing a clear, accessible and widely understood IP system, which enables the economy and

[95] http://www.ipo.gov.uk/about-plan2014.pdf

society to benefit from knowledge and ideas". It offers a range of support services, which together with its overall strategy, are detailed in its corporate strategy [96] (Cunningham, 2015).

Amongst other services, the UKIPO makes public data on the ownership of patents whether in force or ceased and offers a Licence of Right scheme, which allows patent holders to signal that they are willing to grant a licence to anyone who wishes to use their patent in return for a reduced renewal fee on the patent. The IPO maintains a database of patents available under these rules. The UK Government is examining how to make this system more user-friendly and to signpost opportunities for businesses to exploit available technologies and for patent holders to reduce their costs, generate licensing income and ensure that innovations are developed (HMT & BIS, 2014).

The UK Government has recently undertaken a reform of the UK's IP system aimed at helping to put in place the right framework of incentives for creators and investors. It has also improved IP enforcement through a small claims track in the IP Enterprise Court which will is intended to significantly reduce the cost for SMEs of pursuing IP infringement cases. A new Intellectual Property Act, which came into force in October 2014, aimed at the simplification of design and patent protection and introduced new exceptions to copyright law intended to deliver cost savings to businesses through reduced complexity. With the aim of unlocking copyright works that cannot currently be used because the author is unknown, a new scheme for dealing with 'orphan works' was introduced. In addition, the introduction of extended collective licensing for copyright will allow the clearance of multiple rights quickly and cheaply (HMT & BIS, 2014).

Another service offered is the UK 'Easy Access IP' which offers free, licensed access to (currently unused) university IP, in return for some form of recognition for the originator. The Government plans to undertake a review of schemes for IP markets, and the open data information systems they require for support (HMT & BIS, 2014).

Further measures outlined in 'Our plan for growth', alongside access to IP audits, include the planned development of local hubs of expertise in conjunction with partners such as Chambers of Commerce, Patent Libraries, Business and IP Centres, and local authorities. Meanwhile, the UKIPO, in collaboration with the Confederation of British Industry, banks and IP professionals will examine ways in which to bridge the gap in information and understanding between smaller firms which have IP as an asset and potential investors (HMT & BIS, 2014).

A further longstanding measure that should be mentioned is the Lambert toolkit for IP[97] which offers guidelines for universities and companies that wish to undertake collaborative research projects. The objectives of the toolkit are to: facilitate negotiations between potential collaborators, reduce the time and effort required to secure agreement, and provide examples of best practice. The toolkit comprises: a set of 5 model research collaboration (one to one) agreements; 4 consortium (multi-party) agreements; a decision guide and a set of guidance documents.

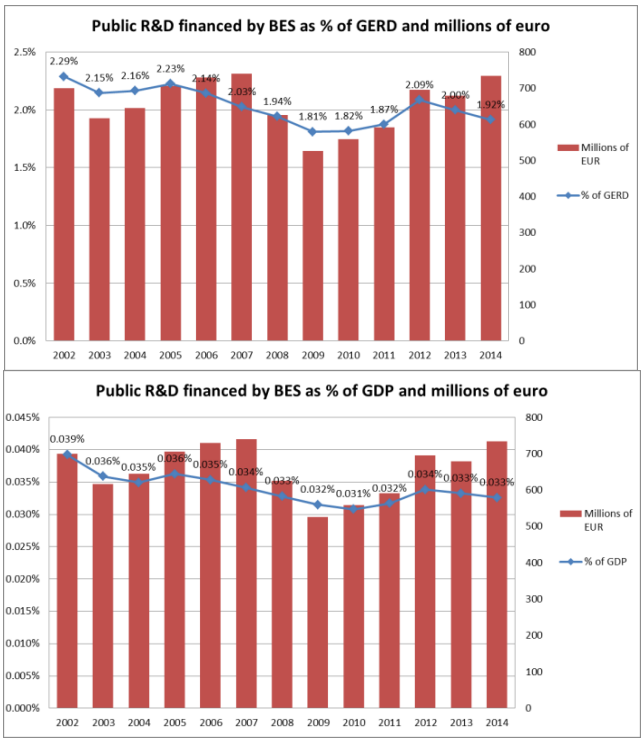
[96] http://www.ipo.gov.uk/ipostrategy.pdf
[97] https://www.gov.uk/guidance/lambert-toolkit

5.7 Public-private partnership and knowledge transfer

5.7.1 Indicators

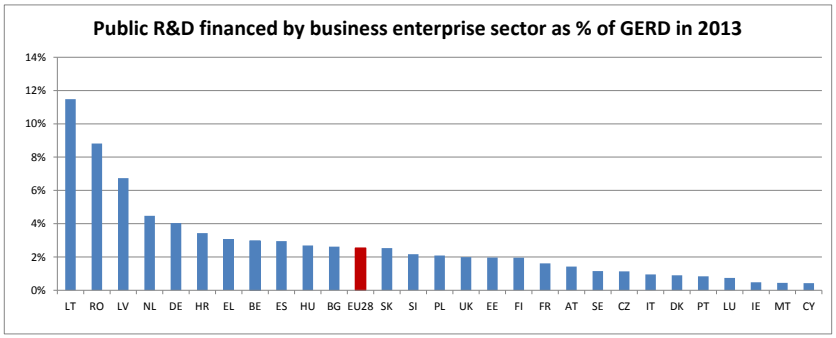
Funding: BES-funded/publicly-performed R&D

Figure 19: BES-funded public R&D as % of GERD (in €MLN) and % of GDP



The level of business enterprise (BES)-funded publicly performed R&D stood at 1.92% as a percentage of GERD. It declined from 2002 until 2009 and then increased, peaking in 2012, after which it dips again. In nominal terms, there was a peak in 2007 at above €700m which after declining, peaks again in 2014. The drop in nominal expenditures after 2007 can partially be explained by variations in the exchange rate between the GBP and the Euro. BES as a percentage of GDP shows a generally stable trend around 0.03% of GDP, peaking in 2002 at 0.39%.

Figure 20: BES-funded public R&D as % of GERD and as % of GDP in 2013 in Member States98



[98] 2011 was chosen as the latest data series providing a full comparison within EU-28.

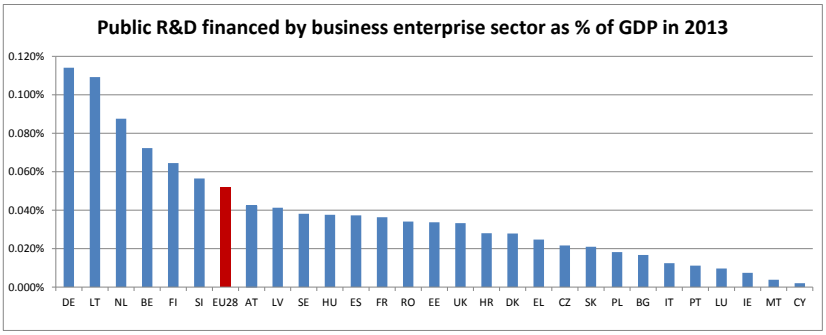


Figure 20 shows BES-funded public R&D in all EU-28 as percentages of GERD and GDP respectively. The UK is below the best performers and EU-28 average on both indicators.

The low level of BES-funded public R&D indicates an overall R&D system with a stronger separation between public and private sectors. UK private sector R&D is characterised by a small number of large companies in a limited number of R&D sectors, and a much larger number of SMEs that do not do R&D. Information on the research base and with whom to collaborate is identified as a major barrier to collaboration. Skills and differences in culture when working on R&D commercialisation also play a role, as do the scope to negotiate intellectual property issues and licensing regimes, although the UK has in place standard models for the latter, e.g. using the Lambert toolbox model. In addition non-financially based knowledge exchange between the public and private sector may also not be captured.

Additional indicators on aspects of the state of knowledge transfer between the public and private sectors are provided in the annual survey of related KE/KT indicators published by HEFCE in its Higher Education-Business and Community Interaction (HE-BCI) Survey.[99] This examines "the exchange of knowledge between universities and the wider world, and informs the strategic direction of 'knowledge exchange' activity that funding bodies and higher education institutions (HEIs) in the UK undertake". The indicators provided in this survey offer a more up to date and detailed picture of the extent of knowledge transfer activities although it may be argued that they provide only an indication of the 'tip of the iceberg' since they do not capture the complete range of collaborative interactions that take place.

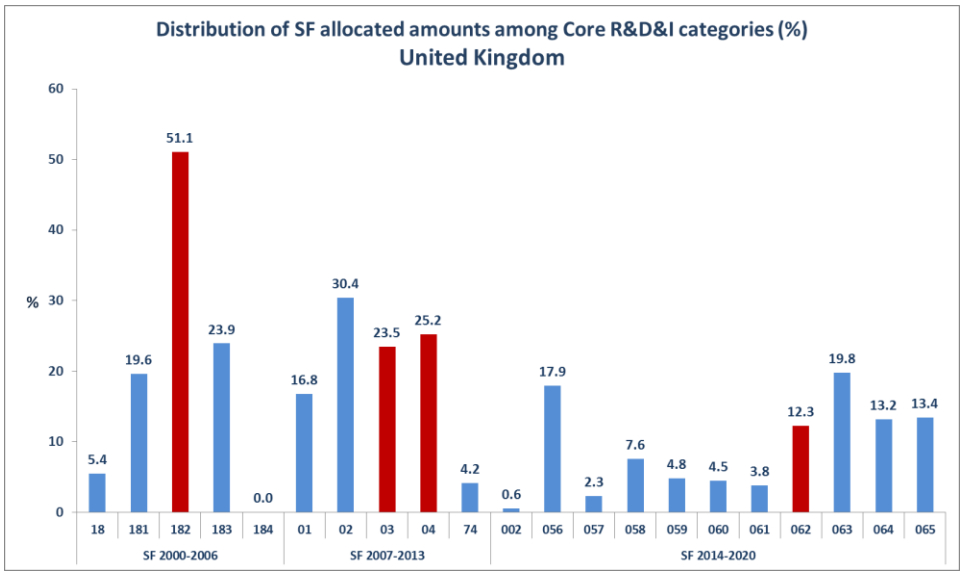
Table 11: UK HE business interaction income

Income of UK HE providers from business and community interactions (£ thousands)			
	2011/12	**2012/13**	**2013/14**
Income from collaborative research involving public funding	874,068	963,027	1,143,879
Value of contract research	1,093,806	1,137,900	1,193,255
Consultancy contracts	397,787	408,155	441,858
Facilities and equipment related services	138,345	143,004	162,926
Courses for business and the community	640,834	653,401	679,076
Income from regeneration and development programmes	172,841	172,171	180,606
Income from Intellectual Property	79,398	86,649	131,117

[99] https://www.hesa.ac.uk/pr/3492-press-release-215

Structural funds allocated to knowledge transfer

Figure 21: Structural Funds for core R&D activities 2000-2006, 2007-2013 and 2014-2020100. We use the categories: 182 (2000-2006), 03 and 04 (2007-2013) and 062 (2014-2020) as proxies for KT activities.

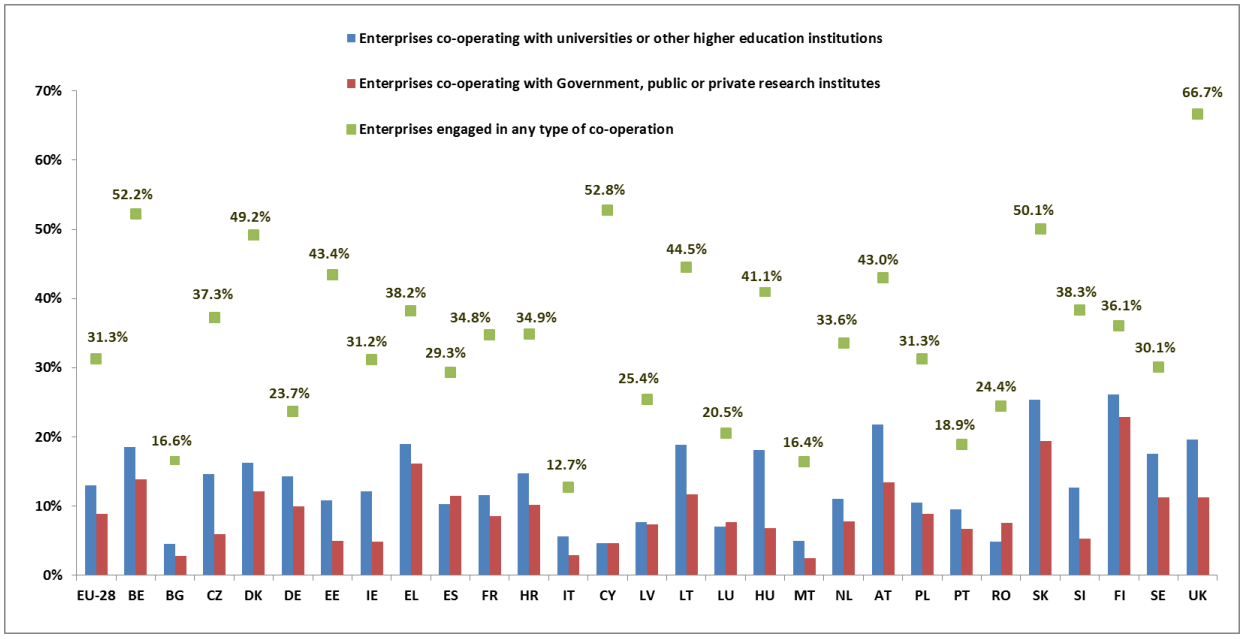


The UK allocated 12.3% of its structural funds for core R&D activities to "Technology transfer and university-enterprise cooperation primarily benefiting SMEs" (compared to 51.1% for 2000-2006 and 48.7% in the 2007-2013 programming period). It is lower than the EU average of 15.7% (the EU average was 26.1% for 2000-2006 and 30.1% for 2007-2013).

Cooperation: Share of innovative companies cooperating with academia

Figure 22: CIS survey 2012 – share of enterprises cooperating with academia

[100] Figure 21 provides the Structural Funds allocated to the United Kingdom for each of the above R&D categories. The red bars show the categories used as proxies for KT. Please note that the figures refer to EU funds and they do not include the part co-funded by the Member State. The categories for 2000-2006 include: 18. Research, technological development and innovation (RTDI); 181. Research projects based in universities and research institutes; 182. Innovation and technology transfers, establishment of networks and partnerships between business and/or research institutes; 183. RTDI infrastructures; 184. Training for researchers.
The categories for 2007-2013 include: 01. R&TD activities in research centres; 02. R&TD infrastructure and centres of competence in specific technology; 03. Technology transfer and improvement of cooperation networks; 04. Assistance to R&TD particular in SMEs; 74. Developing human potential in the field of research and innovation.
The categories for 2007-2013 include: 01. R&TD activities in research centres; 02. R&TD infrastructure and centres of competence in specific technology; 03. Technology transfer and improvement of cooperation networks; 04. Assistance to R&TD particular in SMEs; 74. Developing human potential in the field of research and innovation.
The categories for 2014-2020 include: 002. Research and Innovation processes in large enterprises; 056. Investment in infrastructure, capacities and equipment in SMEs directly linked to Research and Innovation activities; 057. Investment in infrastructure, capacities and equipment in large companies directly linked to Research and Innovation activities; 058. Research and Innovation infrastructure (public); 059. Research and Innovation infrastructure (private, including science parks); 060. Research and Innovation activities in public research centres and centres of competence including networking; 061. Research and Innovation activities in private research centres including networking; 062. Technology transfer and university-enterprise cooperation primarily benefiting SMEs; 063. Cluster support and business networks primarily benefiting SMEs; 064. Research and Innovation processes in SMEs (including voucher schemes, process, design, service and social innovation); 065. Research and Innovation infrastructure, processes, technology transfer and cooperation of enterprises focusing on the low carbon economy and on resilience to climate change.



The UK has the highest percentage of enterprises engaged in any type of cooperation at 66.7%. However, some 19.6% of the total cooperation is with universities and higher education institutions, while. 11.3% cooperate with government or public or private research institutes. These figures are broadly similar to levels in Germany and the Netherlands, although far from Finland's performance - the Innovation Union Scoreboard leader with the highest levels of company-academia cooperation – where 26% of companies work with higher education institutions and 23% with government, public or private research institutes.

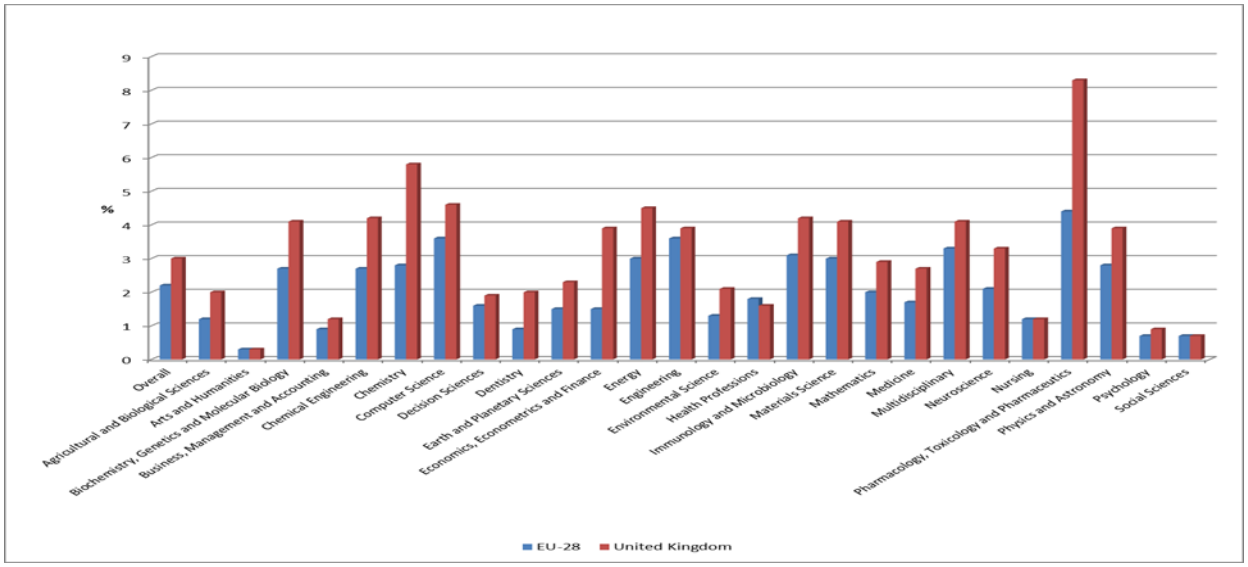
Cooperation: Technology Transfer Offices (TTOs), incubators and technological parks

Measures aimed at the creation of start-ups and spin-offs exist under the broad challenge of increasing the transfer of research results into economic outputs. The creation of science and technology parks, incubators and similar activities are largely the responsibility of the founding organisations – typically universities in partnership with local or regional authorities, development organisations and others. The majority of universities have TTOs in order to support links with business and commercialisation efforts. The UK Science Parks Association lists over 100 locations in the UK (including Science, Research and Technology Parks, Technology Incubators and Innovation Centres) as its members. These provide the environments for some 4,000 companies employing around 75,000 people[101].

[101] http://www.ukspa.org.uk/members#sthash.oyKRXYRv.dpuf

Cooperation: Share of public-private co-publications

Figure 23: Co-publications by field 2003-2013. Scopus database



On average over the period 2003-2013, the top fields for UK public-private co-publication are pharmaceuticals, chemistry, computer science and energy,. The UK is above the EU28 average in the majority of fields. Overall, academia-business publications accounted for 2.9% of publications in 2013 a figure which remained fairly stable over the ten-year period. The UK had 67.5 public-private co-publications per million of population, well above the EU-28 average of 29 (and 57.8 for Germany and 52.5 for France).[102]

Cooperation: Patenting activity of public research organisations and universities together with licensing income

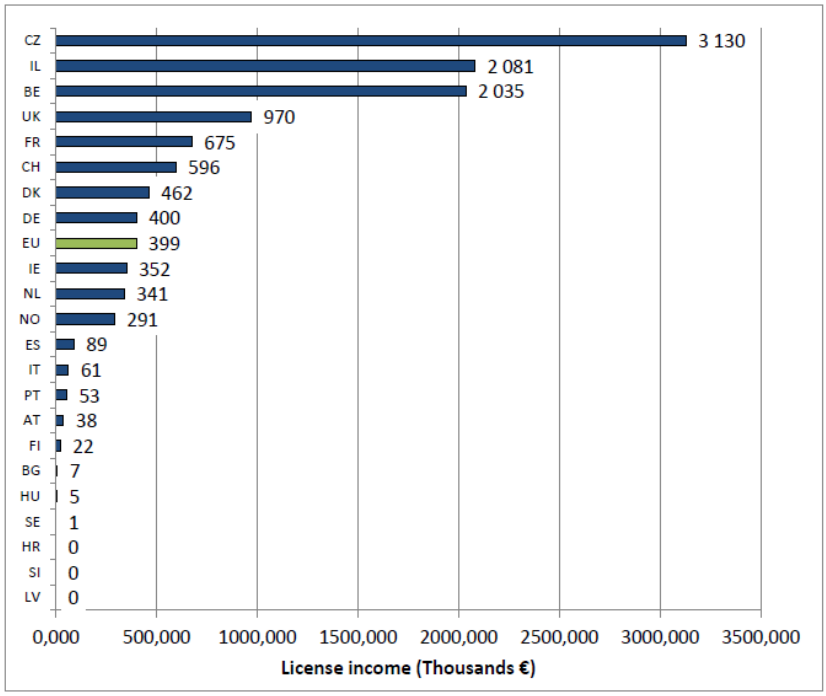
The Knowledge Transfer Study[103] findings show that the UK is quite strong in a number of areas, starting with license agreements (16.3 per 1,000 research staff) and licensing income €970,000 per 1,000 research staff.

However, it performs slightly below the EU average of 4.5 patents per 1,000 research staff (at 4.4), and also below the 82.8 EU average in terms of number of research agreements per 1,000 research staff, with 74.8.

[102] JRC IPTS RIO elaboration on Scopus data collected by Sciencemetrix in a study for the European Commission DG RTD (Campbell, 2013). The share of public-private co-publications is derived from the Scival platform and is also based on Scopus data (September 2015). SciVal® is a registered trademark of Elsevier Properties S.A., used under license. The data on public-private co-publications is not fully compatible with the data included in the IUS, due to differences in the methodology and the publication database adopted.

[103] The survey design however does not always allow for accurate comparisons between countries, e.g. the nature of a national patent in Latvia may be different from a UK patent.

Exhibit 3-35: Thousands Euros of license income per 1,000 research staff by country, EKTIS 2011 and 2012 results combined



Source: MERIT, European Knowledge Transfer Indicator Survey 2011 and 2012.

Figure 24: License income per 1,000 research staff by country. EKTIS 2011-2012 survey

Cooperation: Companies

UK national survey data provides the following results on start-ups and spin-offs. Notably high increases can be seen for graduate start-ups:

Table 12: UK HE Spin off activities

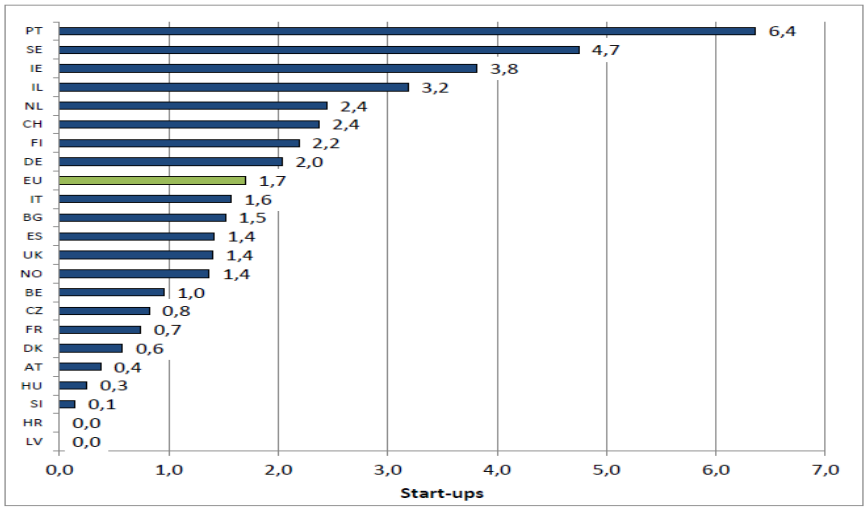
Spin-off activities of UK HE providers			
	2011/12	**2012/13**	**2013/14**
Number of new spin-off companies			
Spin-offs with some HEP ownership	158	130	130
Formal spin-offs, not HEP owned	17	24	17
Staff start-ups	84	64	68
Graduate start-ups	2,729	3,441	4,603
Total number of active firms			
Spin-offs with some HEP ownership	1,045	1,121	1,081
Formal spin-offs, not HEP owned	222	209	174
Staff start-ups	374	431	464
Graduate start-ups	7,151	8,163	9,963
Estimated current employment of all active firms (FTE)			
Spin-offs with some HEP ownership	10,187	10,886	11,358
Formal spin-offs, not HEP owned	7,642	10,769	4,294
Staff start-ups	1,533	1,600	1,617
Graduate start-ups	13,609	15,457	18,560
Estimated current turnover of all active firms (£ thousands)			
Spin-offs with some HEP ownership	899,266	876,950	929,682
Formal spin-offs, not HEP owned	1,124,358	1,742,632	327,555
Staff start-ups	90,580	92,489	83,599
Graduate start-ups	324,895	372,913	474,667
Estimated external investment received (£ thousands)			
Spin-offs with some HEP ownership	651,733	574,562	894,903
Formal spin-offs, not HEP owned	162,915	111,775	91,280
Staff start-ups	30,337	31,926	42,135
Graduate start-ups	31,323	28,814	74,305

Source: HESA, 2015

According to the Knowledge Transfer Study, the UK had 1.4 start-ups per 1,000 research staff which is below the EU average of 1.7.

Figure 25: Number of start-ups per 1,000 of research staff per country

Exhibit 3-33: Number of start-ups per 1,000 research staff by country, EKTIS 2011 and 2012 results combined



Source: MERIT, European Knowledge Transfer Indicator Survey 2011 and 2012.

5.7.2 Policy measures

The challenge of translating the results of publicly supported R&D into commercial products, process and services has led to the development of an extensive range of long-standing measures to promote science-industry collaboration. To this has been added new cluster-type measures (such as Catapults Centres which aim to give businesses access to specialist equipment and emerging technologies and connect them to academic expertise, Knowledge and Innovation Centres and Research and Innovation Campuses) and other incentives, which address a range of actors, through a broad variety of modalities to promote and sustain collaboration for innovation.

The UK's 'Our plan for growth' (HMT & BIS, 2014) notes that the Catapult network will continue to expand with the opening of two more Catapults for Energy Systems and Precision Medicine in 2015 while the High Value Manufacturing Catapult centres will receive a further £61m (c. €77m) funding.

The evidence paper supporting 'Our plan for growth' (BIS, 2014b) notes that "'Open innovation' where firms and other stakeholders collaborate to develop new ideas is an area of increasing policy interest. This is because innovation entails problem-solving, and this frequently involves problems that are outside the existing capabilities of businesses". However, this forms the only mention of the term, possibly since there is extensive academic debate concerning the distinction between 'open innovation' and long standing modes of collaboration. Typically, policy documents tend to assume that the terms collaboration and knowledge exchange are sufficient.

Moreover, the Research Councils support substantial translational activity, including following on funding, as well as Innovation Knowledge Centres and research and innovation campuses. The table below provides for the main measures with details of overall budgets:

Table 13: UK measures and funding supporting collaborations between HE and business

Catapults	Centre bringing business and public sector researchers together to work on late stage R&D projects. 7 open (High Value Manufacturing; Cell Therapy; Offshore Renewable Energy; Satellite Applications; Connected Digital Economy; Future Cities; Transport Systems); 2 due to open 2015 (Energy Systems; Precision Medicine).	£1b earmarked
Catalysts	Run jointly by Innovate UK and Research Councils. Cover: Agri-Tech, Biomedical, Energy and Industrial Biotechnology.	N/A
Collaborative R&D	Long-standing TSB/Innovate UK scheme – promotes industry/academia links	£320m
Knowledge Transfer Networks	Long-standing TSB/Innovate UK scheme - addressed to businesses and higher education and research institutes in order to build partnerships and stimulate active participation in the technology transfer network.	£320m
Knowledge Transfer Partnerships	Long-standing TSB/Innovate UK scheme, involving 12 other supporting bodies. – person focused collaborative projects between academic and business partner.	£119m
Innovation & Knowledge Centres	Based in universities, these are centres of entrepreneurial excellence which aim to create early stage critical mass in an area of disruptive technology. Seven IKCs have received funding (for 5-years) since 2007.	N/A
Higher Education Innovation Fund	HEFCE (and versions supported by Devolved Administrations) – promotes third mission activities by universities	£600m
CASE awards	Research Council-funded postgrad studentship in partnership with businesses and public sector bodies.	N/A
Knowledge Transfer Accounts	EPSRC scheme, used flexibly by universities, aimed at better exploitation of EPSRC-funded research. [Relatively small scale scheme]	N/A
Knowledge Transfer Secondments	EPSRC - support secondment of EPSRC-funded staff into organisations or to host researchers from industry. [Relatively small scale scheme]	N/A

In October 2013, under the banner 'Innovation Scotland', Scotland launched the Single Knowledge Exchange Organisation (SKEO) and in November 2013, it launched a new framework for entrepreneurship and innovation in November 2013 called Scotland Can Do. It also runs Interface, a free, national service which match-makes businesses with research resources in Scotland's universities and research centres with the aim of supporting the establishment of a number of Innovation Centres where businesses and universities can work together. In addition, the Northern Ireland Executive has been working on the development of Competence Centres (Cunningham, 2015).

The 2012 Wilson review set out some 54 recommendations on organisational, management and leadership changes, as well as skills development, while recognising 'a significant improvement in the level and quality of business-university collaboration during the last decade'. The uptake is ongoing and considered only the starting point for work to improve business-university collaboration to ensure graduates are enterprising and prepared for the world of work, to ensure that research and innovation opportunities are fully exploited for UK plc, and to maximise the contribution of universities to local economic growth.[104] University funding under the Research Assessment Exercise in 2014 for the first time included an assessment of impact, of which collaborations with business

[104] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/32399/12-903-following-up-wilson-business-university-collaboration-next-steps.pdf

can form an important part. The more recent Dowling Review[105] pointed out how this appears to be changing the way such collaborations are viewed and valued.

Many of the programmes have undergone several evaluations incl. meta-evaluations, receiving generally positive outcomes (hence longevity of many programmes). Examples of long-standing measures include Knowledge Transfer Partnerships, Collaborative R&D, Knowledge Transfer Networks and Research Council CASE awards. The new approaches being added have not yet been evaluated.

In 2014, the UK Government provided £15m in capital – with twice as much funding from other sources, including private sources – to four pilot University Enterprise Zones (UEZ) to encourage university-business interaction, support the development of incubators and create a space for businesses combined with a wrap-around business support offer.

There is evidence of a strong degree of public-private collaboration as shown by EU and national data, however there is still scope to improve these interactions, notably supporting the commercialisation of public R&D, knowledge exchanges through intersectoral researcher mobility, start-ups and collaborations between the universities and businesses.

The UK considers the issue of university-business collaboration in the context of wider economic and competitiveness goals. National and devolved-government programmes are in place to support a broad range of linkages and collaborations. Actions are also undertaken at the regional and university level to support engagement.

Although the benefits of collaboration to both sides are recognised, the recent 2015 Dowling review outlined new areas for attention such as sectoral weaknesses in knowledge transfer and the complexity and range of schemes. This builds on the previous Wilson review which highlighted there are "too many businesses that are not reaping the rewards" of business-university collaboration.[106]

5.8 Regulation and innovation

While UK public funding supports the entire R&DI process from fundamental research to market innovation, through a mix of direct and indirect measures, the Government also provides general support and governance to improve the overall framework for innovation and research, by policy levers such as improving access to capital, introducing and ensuring compliance with standards and norms and through the introduction and enforcement of regulations. In terms of the latter, the Government strives to ensure that the imposition of regulations adhere to international standards concerning public safety, environmental impact, etc., while at the same time, they do not adversely impact innovation.

The Better Regulation Delivery Office, which operates as an independent unit within BIS, works towards providing a regulatory environment which encourages businesses to invest and grow, and also protects citizens and communities[107]. It does this through the provision of policy advice to UK and Welsh ministers, offers businesses a single local authority as their point of contact for regulation, working with stakeholders to make sure regulation is clear, proportionate and effective, developing tools and resources for regulators and businesses, ensuring the concerns of business are heard and influence policy, helping regulators and businesses work together to solve local issues through LEPs and other means and providing technical assistance to other countries. The Government Office for Science, also based within BIS takes a broader view of the effects

[105] http://www.raeng.org.uk/policy/dowling-review/the-dowling-review-of-business-university-research

[106] BIS, Wilson review of business-university collaboration, February 2012, page 3. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/32383/12-610-wilson-review-business-university-collaboration.pdf

[107] https://www.gov.uk/government/organisations/better-regulation-delivery-office/about

of regulation on innovation and has produced policy guidance reports such as Innovation: managing risk, not avoiding it[108].

A specific example of the UK Government's concern that unnecessary regulation should hamper innovation is provided through its attempts to reduce bureaucracy, particularly that encountered by SMEs. An example is the Cabinet Office 'Red Tape Challenge'[109]. There are also concerns that regulations do not create disadvantages to any businesses, such as the 'One-In, One-Out' rule[110] for new regulation.

5.9 Assessment of the framework conditions for business R&I

As noted in Cunningham (2015), the UK does not articulate strategic actions for research and innovation in the context of legislative frameworks. The Government sets the overall framework conditions for economic growth, which includes business prosperity and investment, through its economic strategy. This was set out in the June Budget 2010 and more recently carried out by the Budget 2014 and Autumn Statement 2014. In parallel, the Devolved Administrations are also taking action to tackle structural reform challenges in areas of devolved competence. These include:

- The Northern Ireland Executive's Programme for Government, Economic and Investment Strategies and, most recently, Together: Building a United Community;
- The Scotland's Government Economic Strategy (GES); and
- The Welsh Government's Programme for Government.

The overall strategy for research and innovation, including business support is embodied in the 2014 Research and Innovation Strategy "Our Plan for Growth" (HMT and BIS, 2014), which sets out the government's approach to boosting business investment in innovation and ensuring the UK's success in the global economy.

Alongside these, government acts to ensure that corporation tax rates remain competitive and that the UK as a whole remains an attractive place to do business. A range of fiscal incentives, supply-side measures and incentives to improve access to finance are in place, involving a mix of public and public-private initiatives. In comparison to supply-side measures, there are a limited number of demand-side measures in place, partly since their role in addressing market and system failures and in stimulating innovation remains to be fully understood and proven.

[108] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/381905/14-1190a-innovation-managing-risk-report.pdf
[109] http://www.redtapechallenge.cabinetoffice.gov.uk/home/index/
[110] https://www.gov.uk/government/collections/one-in-two-out-statement-of-new-regulation

6. Conclusions

Meeting structural challenges

The table below lists the main structural challenges and relevant policy actions, assessing their appropriateness, efficiency and effectiveness, and provides links to relevant evidence (based on evaluations or empirical analyses). Despite its overall good performance, the UK's national R&I system still faces a number of challenges, some of which have been in existence for some time. However, such challenges are, by nature, ongoing and require continuous and integrated policy action in order to deal with them – they are not solvable through 'one off' policy solutions. These ongoing challenges are:

Table 14: Assessment of Performance of National Research & Innovation System: Challenges and responses

Challenge	Policy measures/actions addressing the challenge	Assessment in terms of appropriateness, efficiency and effectiveness
Low level of private and public sector investment in R&D&I	- R&D Tax credits: modification to SME R&D Tax credit - Maintenance of the Science Budget	- Apparently popular measure (the total amount of R&D support claimed in 2012/13 amounting was £1.4b (c. €1.75b) - up £150m on 2011/12), and rising. This provided relief to over 15,500 businesses and supported around £13.2b (c. €16.5b) of investment in 2012-13. UK businesses also reported that 9% or £1.6b (c. €2b) of Business R&D expenditure was funded by government in 2013. (BIS, 2014a)
Translation of the results of publicly supported R&D into commercial products, process and services	- national network of Catapults (£240m between 2011-15) : provides facilities targeted at mid-range Technology Readiness Levels, which would suffer from natural monopoly, or indivisibility issues, due to their high cost. - investment of €58m in graphene research hub, €24m in satellite-based sensing services and €209m in to life sciences commercialisation, plus ££338m in quantum technologies - NIHR Translational Research Partnerships - increased investment in NIHR Biomedical Research Centres/Units - Collaborative R&D (c. €184m in 2012-13) - Knowledge Transfer Networks (KTNs): (c€18m in 2012-13) (new Special Interest Groups in priority areas) - Knowledge Transfer Partnerships (KTPs) (€106m in 2013-14) - Innovation and Knowledge Centres - Higher Education Innovation	- Measure based on thorough review (Hauser, 2010) and positive review in 2014: Catapults are demonstrating positive early impacts, and are building on the existing competencies of the intermediate sector. - investments based on thorough reviews - based on strategic reviews and designed to capitalise on UK research strengths. Too early to assess. - Existing measure. Evidence suggests well used and effective: cost benefit ratio of £7:1. - supports 15 KTNs with over 70,000 members (May 2015) through the Connect web platform. Apparently well-used and successful measure. - Over 712 live projects – apparently popular and successful longstanding measure. Positively evaluated several times - focus on business exploitation of emerging research and technology fields - Good uptake, recently revised allocation process. Delivers RoI of £6.30 gross additional income generated for universities from every £1 invested over the period

Challenge	Policy measures/actions addressing the challenge	Assessment in terms of appropriateness, efficiency and effectiveness
	Fund (€174m per year from 2011-15) – extra €7m input 2012	2003-2012 (BIS, 2014b).
Maintenance of research infrastructure	- UK Research Partnership Investment Fund: budget raised to €336m in 2012 - protection of the science budget 2010-2015 (€23b) A number of investments in new infrastructure facilities, e.g. - Sir Henry Royce Institute for advanced materials (£235m, c. €294m) at the University of Manchester (with satellite centres at Leeds, Liverpool, Sheffield, Cambridge, Oxford and Imperial College). - Cognitive Computing Research Centre (£113m, c. €141m) at the Hartree Centre, Daresbury - Energy Security and Innovation Centres (£31m, c. €39m). - £95m (c. €119m) into European Space Agency programmes - £20m (c. €25m) towards a Centre for Ageing Science and Innovation in Newcastle. - £60m (c. €75m) to extend the capabilities of the National Nuclear Users Facility. - additional €575m of capital investment since 2010: Large Facilities Capital Fund; Research Capital Investment Fund; HEFCE Research Capital allocation - tax breaks worth €174m over 4 years for research & innovation campuses in local Enterprise Zones	- Number of partnerships already in place; Can attract at least double the level of public investment from private and charitable sources. Has so far secured over £1.3b (c. €1.6b) of new Investment in world class research facilities (BIS, 2014b). - Appropriate measure given financial climate; efficient use of resources given need to maintain system stability; indicators (publications, researchers, etc.) seem to indicate effectiveness. - All investment decided after thorough review and preparation of business cases. - measures are appropriate; efficiency and effectiveness are ensured through strategic Large Facilities Roadmap which prioritises needs - regional measure aimed at improving performance of centres of excellence for business-research innovation activities
Ensure future supply of HRST	- existing range of research training through Research Councils (incl. CASE awards), move towards delivery through teaching/research clusters and centres of excellence	- addresses both generic and more specific employee skills needs. There is still demand from employers for additional skills sets. - ensures delivery of appropriately trained researchers into the research

Challenge	Policy measures/actions addressing the challenge	Assessment in terms of appropriateness, efficiency and effectiveness
	- continuing review of training and teaching needs addressed by HE funding bodies and research councils - support for early career post-doctoral research and career development fellowships through Royal Societies, Research Councils and British Academy - Increased support for Apprenticeships schemes in 2011 – further expansion announced in 2014 Plan for Growth. - Richard Review of Apprenticeships published Nov 2012 – Government adopted number of recommendations in Spring, 2013 and further Higher Apprenticeships planned.	base and business - support for excellent researchers, addresses need to maintain quality as lynch pin of research support - addresses absence of adequate pathway for lower level technical skills provision – skills addressed at several levels Appears to be addressing needs as perceived by Richards Review
Support for SME growth and scale-ups	- R&D Tax credits: increased rate to 225% for SMEs + small changes in 2014: cost to government in 2010/11 = c. £1,460[111] - Smart scheme (budget increased to €62.5m in 2014-15) - Business Coaching For Growth - Manufacturing Advisory Service - Business Link - Growth Accelerator - OpentoExport - Enterprise Capital Funds programme increased by €500m over 3 years (Autumn 2014) -UK Innovation Investment Fund - Enterprise Finance Guarantee: extended Autumn 2014 to provide c. 625m of new funding by 2015/16. - Venture Capital Trusts - Business Angel Co-Investment Fund (€58m) Enterprise Investment Scheme and Seed Enterprise Investment Scheme	- based on recent assessment of tax credit; effective and efficient measure - Long-standing measure – addresses finance market failure, positively evaluated [112] . 2009 evaluation found cost benefit ratio of 9:1 - Advisory services: add further dimension to increase absorptive capacity. - addresses decrease in availability of VC due to credit crunch. Too early to assess. - positive review in 2012 - lending hit record low in late 2012 – requires increased uptake/effectiveness - in October 2012, amount of money invested in VCTs fell for first time since start of credit crisis as investors switched to Enterprise Investment Schemes. - supports UK business angels market against economic downturn. Since launch, has invested and committed over £24m (c. €30m) alongside a further £95m (c. €120m) from business angels and other investors, providing support for 54 companies. The fund retains

[111] BIS (2014d)
[112] E.g. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/344917/report107.pdf

Challenge	Policy measures/actions addressing the challenge	Assessment in terms of appropriateness, efficiency and effectiveness
	- encouraged five main banks to set up a Business Growth Fund of €2.9b to fund high growth companies - Leveraging of ERDF funding for innovation - awareness raising on Smart Specialisation - innovation voucher scheme (agri-food and built environment) - extension of Launchpad: designed to strengthen clusters through facilitating cooperation and networking	100% follow-on capacity. - stimulates investment support in financial downturn. Too early to assess effects. - addresses lack of supply of bank capital support for small companies engendered by credit crunch. 2012/13 review[113] suggests modest increase of uptake since previous year - channels ERDF support to regional needs through existing measures - based on regional pilots, will focus on sector with low levels of private sector innovation and growth - tailored to specific local needs. Early examples appear to be successful.
Support for public procurement and demand led innovation	Small Business Research Initiative Budget 2013 announced Government's intention to increase value of contracts c. €50m in 2012-13 to over c. €250m in 2014-15. Innovation Platforms (c.€250m) BIS exploring options for a new Centre of Expertise to provide expert advice on the development of innovation to the public sector Package of measures to standardise procurement, etc. with NHS	Appropriate to policy goals of investigating potential of demand led innovation from Government. Some examples of success. Evaluation under way (2015). Since 2009, has delivered 215 competitions from 70 public bodies and resulted in 1,850 contracts worth £210m (c. €262m). Address sectoral demand issues (linked to societal challenge areas) through collaborative activities; strong connection to KTNs Too early to assess Too early to assess

[113] Branching out. How Growth Capital can seed success. Review 2012/13.
Available at: http://www.businessgrowthfund.co.uk/wp-content/uploads/2013/07/Review-2013.pdf

References

BIS (2015a) Annual Report and Accounts 2014-15. HC75, Department for Business, Innovation and Skills. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/444896/BIS-15-421-BIS-Annual-Report-15-web.pdf

BIS (2015b) the Dowling Review of Business-University Research Collaborations, BIS, July 2015. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/440927/bis_15_352_The_dowling_review_of_business-university_rearch_collaborations_2.pdf

BIS (2014a). Insights from international benchmarking of the UK science and innovation system. Ref: BIS/14/544, February 2014. Available at: https://www.gov.uk/government/publications/science-and-innovation-system-international-benchmarking.

BIS (2014b) Our Plan for Growth: Science and Innovation Evidence Paper, December 2014. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/388015/14-1247-science-innovation-strategy-evidence.pdf

BIS (2014c) Annual Innovation Report: Innovation, Research and Growth, March 2014. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/293635/bis-14-p188-innovation-report-2014-revised.pdf

BIS (2014d) The Allocation of Science and Research Funding 2015/16: Investing in World-Class Science and Research, May 2014. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/332767/bis-14-750-science-research-funding-allocations-2015-2016-corrected.pdf

BIS (2014e) European Regional Development Fund and European Social Fund: UK allocations 2014 to 2020, Letter, 17 April 2014. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/307492/bis-14-772-uk-allocations-eu-structural-funds-2014-2020-letter.pdf

BIS (2014f) Outcome of consultation: Creating the future: a 2020 vision for science and research - government response to consultation on proposals for long-term capital investment in science and research. Available at: https://www.gov.uk/government/consultations/science-and-research-proposals-for-long-term-capital-investment

BIS (2013) International Comparative Performance of the UK Research Base – 2013, Ref: BIS/13/1297. December 2013. Available at: https://www.gov.uk/government/publications/performance-of-the-uk-research-base-international-comparison-2013.

BIS (2011) Delivering best value through innovation: Forward Commitment Procurement, Practical Pathways to Buying Innovative Solutions. November 2011. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/32446/11-1054-forward-commitment-procurement-buying-innovative-solutions.pdf

BIS (2010) Guidelines for Managing Programmes: Understanding Programmes and Programme Management. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/31978/10-1256-guidelines-for-programme-management.pdf

Cunningham, P.N., Karakasidou, A. (2009) ERAWATCH COUNTRY REPORTS 2009: United Kingdom. Analysis of policy mixes to foster R&D investment and to contribute to the ERA. Report to European Commission, IPTS and DG Research as part of the ERAWATCH Network Activity, April 2009.

Cunningham, P.N., (2015) RIO Country Report 2014: United Kingdom. JRC-IPTS, European Commission.

Deloitte (2014). Researchers' Report 2014, Country Profile: United Kingdom. Available at: http://ec.europa.eu/euraxess/pdf/research_policies/country_files/United_Kingdom_Country_Profile_RR2014_FINAL.pdf

Edqvist C. & Zabala-Iturriagagoitia, JM: The Innovation Union Scoreboard is Flawed: The case of Sweden – not being the innovation leader of the EU. Lund University. Papers in Innovation Studies no. 2015/16.

http://wp.circle.lu.se/upload/CIRCLE/workingpapers/201516_Edquist_ZabalaIturriagagoitia.pdf

European Commission (2015) Country Report United Kingdom 2015 Including an In-Depth Review on the prevention and correction of macroeconomic imbalances, (COM(2015) 85 final), European Commission. Available at: http://ec.europa.eu/europe2020/pdf/csr2015/cr2015_uk_en.pdf

European Commission (2014) The ERA-NET scheme from FP6 to Horizon 2020: Report on ERA-NETs, their calls and the experiences from the first calls under Horizon 2020.

European Commission (2014a) European Research Area Progress Report 2014, {COM(2014) 575 final}. Available at: https://ec.europa.eu/research/era/pdf/era_progress_report2014/era_fiches_eu-3_2014.pdf

EVCA (2012) Tax benchmark study 2012, European Private Equity and Venture Capital Association, Brussels. Available at: http://www.investeurope.eu/uploadedFiles/Benchmark2012.pdf?dm_i=1GLS,1K23D,827W8K,5C4G8,1

Government Economic Service (2014). 'Innovation and economic growth: Government Economic Service report'. Available at: https://www.gov.uk/government/publications/innovation-and-economic-growth-government-economic-service-report

Hauser, H (2014) Review of the Catapult network: Recommendations on the future shape, scope and ambition of the programme, Department for Business, Innovation and Skills, 2014. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/368416/bis-14-1085-review-of-the-catapult-network.pdf

HESA (2015) Higher Education-Business and Community Interaction (HE-BCI) Survey 2013/14, Available at: https://www.hesa.ac.uk/index.php?option=com_content&view=article&id=2092&Itemid=634

HM Government (2015), Europe 2020: UK National Reform Programme 2015. March 2015. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/417890/UK_NRP_2015_final.pdf

HM Government (2014) Review of the Balance of Competences between the United Kingdom and the European Union: Research and Development. February 2014. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/279331/bis_14_592_balance_of_competences_review_government_reponse_to_the_call_for_evidence.pdf

HM Revenue and Customs (2014). Research and Development Tax Credit Statistics. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/356382/Research_and_Development_Tax_Credits_-_August_2014.pdf

HM Treasury (2015) Fixing the foundations: Creating a more prosperous nation, Cm 9098, July 2015. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/443898/Productivity_Plan_web.pdf

HM Treasury and BIS, (2014) Our plan for growth: science and innovation, CM 8980, December 2014. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/387780/PU1719_HMT_Science_.pdf

Innovate UK (2015) Annual Report and Accounts 2014-2015. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/446302/FINAL_-_Innovate_UK_Accounts_2014-15_.pdf

Kolev, G. and Matthes, J. (2013) Smart Fiscal Consolidation: A Strategy for Achieving Sustainable Public Finances and Growth, Centre for European Studies/Cologne Institute for Economic Research.

Northern Ireland Executive (2012), Economic Strategy Priorities for sustainable growth and prosperity: building a better future. March 2012. Available at: http://www.northernireland.gov.uk/ni-economic-strategy-revised-130312.pdf

Nurse, Sir Paul, (2015) Ensuring a successful UK research endeavour, A Review of the UK Research Councils, BIS/15/625, November 2015. Available at: https://www.gov.uk/government/publications/nurse-review-of-research-councils-recommendations

OECD (2015) Making Open Science a Reality, OECD Publishing, Paris. Available at: https://www.innovationpolicyplatform.org/sites/default/files/DSTI-STP-TIP%282014%299-REV2-for%20declassification%20-%20US%20and%20other%20comments%20addressed-numbers-removed.pdf

Office of National Statistics (2015) Gross UK Research and Development Historical Data: available at: http://www.ons.gov.uk/ons/rel/rdit1/gross-domestic-expenditure-on-research-and-development/2013/tsd-gerd-2013.html

Office of National Statistics (2015), Statistical Bulletin: Business Enterprise Research and Development: 2013. Available at: http://www.ons.gov.uk/ons/dcp171778_385959.pdf

Office for National Statistics (2015) Summary of Public Sector Finances, July 2015. ONS, August 2015. Available at: http://www.ons.gov.uk/ons/dcp171780_414304.pdf.

Office of National Statistics (2014), Statistical Bulletin: UK Business: Activity, Size and Location, 2014. Available at: http://www.ons.gov.uk/ons/dcp171778_382567.pdf

Review of the Joint Programming Process: Final Report of the Expert Group, 2012

Smith, A (2015) Research council merger still a live issue: Secretive McKinsey review implies threats to science spending, Research Fortnight, 5 August 2015. http://www.researchresearch.com/index.php?option=com_news&template=rr_2col&view=article&articleId=1353982

UK Space Agency (2014) Review and Evaluation of the National Space Technology Programme: An evaluation of the funding programme portfolio against delivering support for growth of the space sector, Swindon, November, 2014.

UKTI (2015), Inward Investment Report 2014 to 2015. UK Trade and Investment, London.

Abbreviations

AHRC	Arts and Humanities Research Council
BBSRC	Biotechnology and Biological Sciences Research Council
BERD	Business Enterprise Expenditure on R&D
BIS	Department for Business, Innovation and Skills
CBI	Confederation of British Industry
CSA	Chief Scientific Adviser
CSR	Comprehensive Spending Review
CST	Council for Science and Technology
DAs	Devolved Administrations
DCLG	Department for Communities and Local Government
DCMS	Department for Culture, Media and Sport
DEFRA	Department for Environment, Food and Rural Affairs
DFID	Department for International Development
DH	Department of Health
EPSRC	Engineering and Physical Sciences Research Council
ERA	European Research Area
ESFRI	European Strategy Forum on Research Infrastructure
ESRC	Economic and Social Research Council
FE	Further Education
fEC	Full Economic Costing
FP	European Framework Programme for Research and Technology Development
G7	Group of seven industrialised nations
GBAORD	Government Budget Appropriations or Outlays for R&D
GDP	Gross Domestic Product
GERD	Gross Expenditure on R&D
GSIF	Global Science and Innovation Forum
HE	Higher Education
HE-BCI	Higher Education-Business and Community Interaction
HEFCE	Higher Education Funding Council for England
H2020	Horizon 2020
HEI	Higher Education Institutions
HEIF	Higher Education Innovation Fund
HERD	Higher Education Expenditure on R&D
HMRC	Her Majesty's Revenue and Customs (Tax Agency)
HM Treasury	Her Majesty's Treasury (Finance Ministry)
KTN	Knowledge Transfer Network
KTP	Knowledge Transfer Partnership
LCFC	Large Facilities Capital Fund
LEP	Local Economic Partnership
MoD	Ministry of Defence
MRC	Medical Research Council
NAO	National Audit Office
NERC	Natural Environment Research Council
NESTA	National Endowment of Science Technology and the Arts
NHS	National Health Service
NRP	National Reform Programme
OECD	Organisation for Economic Co-operation & Development
OLS	Office for Life Sciences
ONS	Office for National Statistics
PRO	Public Research Organisation
PSA	Public Service Agreement

PSRE	Public Sector Research Establishment
RAE	Research Assessment Exercise
RCIF	Research Capital Investment Fund
RCUK	Research Councils UK
RDA	Regional Development Agency
REF	Research Excellence Framework
RTO	Research & Technology Organisations
S&T	Science and Technology
SBRI	Small Business Research Initiative
SET	Science, Engineering and Technology
SME	Small and Medium-sized Enterprise
STEM	Science, Technology, Engineering & Mathematics
STFC	Science and Technology Facilities Council
TSB	Technology Strategy Board – now Innovate UK
UKTI	UK Trade and Investment
UTC	University Technical College
UUK	Universities UK
VCT	Venture Capital Trust

List of Figures

List of Tables

Annex 1 – List of the main research performers

UK top 10 R&D performers (public based on publications)

University	Total number of publications recorded in Scopus database 2005 to date (as of 24 August 2015)											
	Total	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Univ. College London	109140	7442	8340	8793	9100	9809	10390	10695	12014	12785	12370	7402
Univ. Oxford	95301	6041	6671	7077	7734	8464	9107	9854	11026	11583	11067	6677
Univ. Cambridge	90158	6844	7280	7227	7741	8142	8587	9200	10106	9832	9583	5616
Imperial College London	72320	5269	5523	5714	6099	6555	6814	7395	7678	8186	8265	4822
Univ. Manchester	65514	4743	5311	5730	6040	6004	6297	6468	7088	7057	6815	3961
King's College London	50972	3363	3609	3825	4341	4542	4830	5190	5949	6315	5612	3396
Univ. Edinburgh	50900	3535	3670	4121	4415	4744	4870	5080	5792	5856	5728	3089
Univ. Bristol	41582	3052	3336	3550	3661	3883	3950	3960	4443	4549	4580	2618
Univ. Birmingham	40214	2914	3211	3446	3596	3766	3789	3803	4346	4544	4298	2501
Univ. Nottingham	39974	2699	2836	3395	3511	3727	3957	4187	4338	4557	4378	2389

UK top 10 R&D performers (private based on R&D expenditures)

UK Rank	EU rank	Name	Industrial sector (ICB-3D)	R&D 2013 (€million)
1	7	GLAXOSMITHKLINE	Pharmaceuticals & Biotechnology	4,154.3
2	13	ASTRAZENECA	Pharmaceuticals & Biotechnology	3,202.8
3	29	ROYAL BANK OF SCOTLAND	Banks	1,083.1
4	34	ROYAL DUTCH SHELL	Oil & Gas Producers	955.7
5	36	DELPHI	Automobiles & Parts	942.6
6	42	BT	Fixed Line Telecommunications	823.9
7	45	ROLLS-ROYCE	Aerospace & Defence	791.7
8	49	BARCLAYS	Banks	736.8
9	52	SHIRE	Pharmaceuticals & Biotechnology	645.5
10	58	HSBC	Banks	530.1

Source: EU R&D Scoreboard 2014: http://iri.jrc.ec.europa.eu/scoreboard14.html

Annex 2 – List of the main funding programmes

Name of the funding programme	Timeline	Budget	Target group
R&D Tax Credits	since 2007	c. €1.5b tax relief 2011/12	All companies
Catapults	since 2011	c. €300m - 2011-15	Companies (Inc. SMEs), HEIs, RTOs
Catalysts	since 2011	c. €56m p.a. (c. €440m since 2011)	biomedical, agri-tech, biotech and energy sector innovation actors, particularly HEIs
Collaborative R&D	since 2004	c. €184m - 2012-13	Companies and researchers
Knowledge Transfer Networks	since 2004	c. €19m – 2012-13	Industry, HEIs, RTOs, Not-for Profit
Knowledge Transfer Partnerships	Since 1975	c. €45m – 2014-15	Companies and HEIs
Innovation & Knowledge Centres	Since 2007	c. €12.5m per IKC	HEIs, companies
Higher Education Innovation Fund	Since 2001	c. €200m – 2015-16	HEIs
CASE awards	Since 1994	not known	Companies, HEIs, PSREs, Government bodies
UK Research Partnership Investment Fund	Since 2012	c. €500m 2014-16	HEIs, co-funding from industry
Innovation Vouchers	Since 2008	c. €7.5m - 2014-15[114]	SMEs
Smart	Since 1986	c. €62.5m - 2014-15	SMEs
Launchpads	Since 2013	c. €1.3m per Launchpad (7)	Clusters of high-tech companies
Small Business Research Initiative (SBRI)	Since 2009	c. €250m – 2014-15	Mainly SMEs
Manufacturing Advisory Service (MAS		c. €22.5m – 2014-15	All manufacturing companies, especially SMEs
Enterprise Capital Funds	Since 2006	c. €250m – 2012-15	SMEs
UK Innovation Investment Fund	Since 2010	c. €31m – 2014-15	Start-ups and spin-outs
Enterprise Finance Guarantee	Since 2009 (replaced Small Firms Loan Guarantee)	c. €360m committed debt (2015)	Viable businesses unable to access finance due to inadequate security or proven track record
Venture Capital Trusts	Since 1995	unknown	SMEs
Business Angel Co-Investment Fund	Since 2011	c. €30m invested since launch	SMEs

Note: Budget figures are government investment and do not include industry, HEI or PSRE co-funding or in-kind support. Main sources: Innovate UK (2015); BIS (2015a).

114 Innovate UK funds – other funders also exist (e.g. UK Research Councils)

Annex 3 – Evaluations, consultations, foresight exercises

Completed

- BIS (2013). Encouraging a British Invention Revolution: Sir Andrew Witty's Review of Universities and Growth, October 2013. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/249720/bis-13-1241-encouraging-a-british-invention-revolution-andrew-witty-review-R1.pdf
- BIS (2014f) Outcome of consultation: Creating the future: a 2020 vision for science and research - government response to consultation on proposals for long-term capital investment in science and research. Available at: https://www.gov.uk/government/consultations/science-and-research-proposals-for-long-term-capital-investment
- BIS (2015b) The Dowling Review of Business-University Research Collaborations, BIS, July 2015. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/440927/bis_15_352_The_dowling_review_of_business-university_rearch_collaborations_2.pdf
- Hauser, H (2014) Review of the Catapult network: Recommendations on the future shape, scope and ambition of the programme, Department for Business, Innovation and Skills, 2014. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/368416/bis-14-1085-review-of-the-catapult-network.pdf
- Innovate UK, (2015?) Review of the thematic KTPs programme since 2011. Unpublished?
- Innovate UK (2015) Evaluation of the Small Business Research Initiative. Unpublished.
- Nurse, Sir Paul, (2015) Ensuring a successful UK research endeavour, A Review of the UK Research Councils, BIS/15/625, November 2015. Available at: https://www.gov.uk/government/publications/nurse-review-of-research-councils-recommendations
- UK Space Agency (2014) - public consultation on the contents of a new National Strategy for Space Environments and Human Spaceflight. Available at: https://www.gov.uk/government/consultations/national-strategy-space-environments-and-human-spaceflight

Ongoing

- McKinsey "efficiency and effectiveness review" of BIS-funded bodies, including Research Councils, HEFCE and Innovate UK.

Planned

- Evaluation of REF 2014 – consultation by HEFCE, planned after 2015 CSR.

Europe Direct is a service to help you find answers to your questions about the European Union
Free phone number (*): 00 800 6 7 8 9 10 11
(*) Certain mobile telephone operators do not allow access to 00 800 numbers or these calls may be billed.

A great deal of additional information on the European Union is available on the Internet.
It can be accessed through the Europa server http://europa.eu

How to obtain EU publications

Our publications are available from EU Bookshop (http://bookshop.europa.eu),
where you can place an order with the sales agent of your choice.

The Publications Office has a worldwide network of sales agents.
You can obtain their contact details by sending a fax to (352) 29 29-42758.

LF-NA-27875-EN-N

JRC Mission

As the Commission's in-house science service, the Joint Research Centre's mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle.

Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new methods, tools and standards, and sharing its know-how with the Member States, the scientific community and international partners.

Serving society
Stimulating innovation
Supporting legislation

Publications Office

doi:10.2791/7240743

ISBN 978-92-79-57810-6